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COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

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COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

At the session of 1903 the State Legislature passed the following act to regulate the sale of commercial fertilizers:

CHAPTER CCXXV.—*An act to regulate the sale of commercial fertilizers or materials used for manurial purposes, and to provide penalties for the infraction thereof, and means for the enforcement of the act.*

[Approved March 20, 1903.]

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. Every lot, parcel, or package of commercial fertilizers or materials to be used for manurial purposes (excepting the dung of domestic animals), sold, offered, or exposed for sale, within this State, shall be accompanied by a plainly printed label, stating the name, brand, and trade mark, if any there be, under which the fertilizer is sold, the name and address of the manufacturer, importer, or dealer, the place of manufacture, and a chemical analysis, stating the percentages claimed to be therein; of nitrogen, specifying the form or forms in which it is present; of phosphoric acid, available and insoluble; and of potash, soluble in distilled water, and the materials from which all of said constituents are derived. All analyses are to be made according to the methods agreed upon by the American Association of Official Agricultural Chemists. In the case of those fertilizers, the selling price of which is less than eight dollars ($8) per ton, said label need only give a correct general statement of the nature and composition of the fertilizer it accompanies.

SEC. 2. No person shall sell, offer, or expose for sale in this State, any pulverized leather, hair, ground hoofs, horns, or wool waste, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of a fertilizer or manure, without an explicit statement of the fact; said statement to be conspicuously affixed to every package of such fertilizer or manure, and to accompany and go with every lot, parcel, or package of the same.

SEC. 3. The manufacturer, importer, agent of, or dealer in any commercial fertilizers, or materials used for manurial purposes, the selling price of which to the consumer is eight ($8) dollars or more per ton, shall, before the same is offered for sale, obtain a certificate of registration from the Secretary of the Board of Regents of the University of California, countersigned by the Director of the Agricultural Experiment Station of the said University, authorizing the sale of fertilizers in this State, and shall securely fix to each lot, parcel or package of fertilizer the word "registered" with the number of registry. The manufacturer, importer, agent, or dealer, obtaining such registry, shall pay to the said Secretary the sum of fifty ($50) dollars, to be applied as provided in section nine of this act; such registration shall expire on the thirtieth day of June of the fiscal year for which it was given; *provided*, the provisions of this section shall not apply to any agent whose principals shall have obtained a certificate of registration as herein

provided. Every such manufacturer, importer, agent, or dealer, who makes or sells, or offers for sale, any such substances, under a name or brand, shall file, on or before the first day of July, in each year, a statement, under oath, with said Director, stating such name or brand, and stating the component parts in accordance with the provisions of section one of this act, of the substances to be sold, or offered for sale, or manufactured under each such name or brand.

SEC. 4. The said Director shall annually, on or before the first day of September, take samples in accordance with the provisions of section five hereof of the substance made, sold, or offered for sale, under every such name or brand, and cause analyses to be made thereof in accordance with the provisions of section one hereof, and said analyses may include such other determinations as said Director may at any time deem advisable. Dealers in, or manufacturers of fertilizers, must give free access to the Director of the Agricultural Experiment Station, or his duly authorized deputy, to all the materials which they may place on the market for sale in California. Whenever the analysis certified by the said Director shall show a deficiency of not more than one fourth of one per cent of nitrogen, or one per cent of soluble or available phosphoric acid, or one half of one per cent of potash soluble in distilled water, the statement of the manufacturer or importer, as required in section one of this act, shall not be deemed to be false in the meaning of this act; *provided*, that this act shall not apply to sales of fertilizing materials made to a registered manufacturer of fertilizers, or to sales for export outside of this State; *provided further*, that the said Director of the Agricultural Experiment Station of the University of California shall, upon the receipt of a sample of fertilizer, accompanied with a nominal fee of two ($2) dollars, furnish to the user of said commercial fertilizer, such examination or analysis of the sample as will substantially establish the conformity or non-conformity of the said fertilizer to the guarantee under which it was sold.

SEC. 5. The Director of the Agricultural Experiment Station of the University of California, in person or by deputy, is hereby authorized to take a sample not exceeding two pounds in weight for analysis by the said Director, or his deputies, from any lot, parcel, or package of fertilizer, or material, or mixture of materials used for manurial purposes, which may be in the possession of any manufacturer, importer, agent, or dealer, but said sample shall be drawn in the presence of said party or parties in interest, or their representatives. In lots of five tons or less, samples shall be drawn from at least ten packages, or, if less than ten packages are present, all shall be sampled; in lots of over five tons, not less than twenty packages shall be sampled. The samples so drawn shall be thoroughly mixed, and from it two equal samples shall be drawn and placed in glass vessels, carefully sealed, and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn, and the time and place of drawing; and said label shall also be signed by the said Director or his deputy making such inspection, and by the party or parties in interest, or their representatives present at the drawing and sealing of said samples. One of said duplicate samples shall be retained by the party whose stock was sampled, and the other by the Director of the Agricultural Experiment Station of the University of California.

SEC. 6. The Director of the Agricultural Experiment Station of the University of California shall publish in bulletin form, from time to time, at least annually, the results of the analysis hereinbefore provided, with such additional information as circumstances may advise.

SEC. 7. There is hereby appropriated for the use of the Agricultural Experiment Station of the University of California at Berkeley, Alameda County, as set forth in this act, out of any moneys in the treasury not otherwise appropriated, the sum of eighteen hundred ($1,800) dollars for the equipment of a laboratory, with the chemicals and apparatus, and other incidentals necessary to the successful prosecution of the work.

SEC. 8. In order to further provide for the necessary expenses of this work, there shall be paid by the manufacturer, importer, agent, or dealer, twenty-five cents for every ton of fertilizer sold, the selling price of which to the consumer is eight ($8) dollars or more per ton. A statement sworn to by the manufacturer, importer, agent, or dealer, of such sales, shall be rendered quarterly to the Secretary of the Board of Regents of

the University of California, accompanied by the corresponding amount of the special license fee as above specified; *provided*, that whenever the manufacturer or importer shall have paid the special license fee herein required, for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the special license fee named in this section. On receipt of said special license fee and statement, the said Secretary shall issue to the manufacturer, importer, agent, or dealer, a certificate of compliance with this section.

SEC. 9. All moneys, whether received from registry and analytical fees or special license fees, shall be paid to the Secretary of the Board of Regents of the University of California, for the use of said board in carrying out the provisions of this act.

SEC. 10. Any party selling, offering, or exposing for sale, any commercial fertilizer without the statement required by section one of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is actually contained therein, except as provided for in section four, or respecting the sale of which all the provisions of this act have not been fully complied with, shall be deemed guilty of a misdemeanor, and upon conviction thereof before any court of competent jurisdiction, shall be fined in a sum not less than fifty ($50) dollars and costs of action for the first offense, and one hundred ($100) dollars and costs of the action for each subsequent offense. Said fines to be paid into the school fund of the county in which conviction is had.

SEC. 11. In any action, civil or criminal, in any court in this State, a certificate under the hand of said Director, and the seal of said University, stating the results of any analysis, purporting to have been made under the provisions of this act, shall be prima facie evidence of the fact that the sample or samples mentioned in said analysis or certificate were properly analyzed as in this act provided; that such samples were taken as in this act provided; that the substances analyzed contained the component parts stated in such certificate and analysis; and that the samples were taken from the parcels or packages or lots mentioned or described in said certificate.

SEC. 12. This act shall take effect and be in force from and after July first, nineteen hundred and three.

The following is a list of dealers and manufacturers who registered for the year ending June 30, 1904, together with the names or brands of the fertilizers and the fertilizing materials which they offered for sale. The star (*) preceding a brand signifies that the fertilizer inspector was unable to find a sample on the market:

Agricultural Chemical Works, Los Angeles, Cal.

Registration No. 8.

*The Woodbridge Apricot.
Bat Guano.
The Woodbridge Berry.
*Bird Guano.
*Blood Meal.
*Fine Ground Bone.
*The Woodbridge Grape.
The Woodbridge Lawn.
*The Woodbridge Lemon No. 1.
*Muriate of Potash.
Nitrate of Soda.
*The Woodbridge Nursery.
*The Woodbridge Olive.
The Woodbridge Orange and Lemon No. 1.
The Woodbridge Orange and Lemon for Heavy Soil.
The Woodbridge Orange and Lemon for Light Soil.
The Woodbridge Orange and Lemon for Non-fruiting Trees.
The Woodbridge Peach.
*The Woodbridge Potato.
*The Woodbridge Prune.
*The Woodbridge Rose.
*Sulphate of Potash.
Superphosphate.
Tankage.
*The Woodbridge Vegetable.
*The Woodbridge Walnut and Almond.

American Agricultural Chemical Co., California Works, Los Angeles, Cal.

Registration No. 1.

*Acid Phosphate.
Bradley's California Vegetable.
*Coarse Raw Bone.
Bradley's Fruit and Vine.
Bradley's Special Fruit and Vine.
*Bradley's Walnut.
Bradley's Lawn.
*Nitrate of Soda.
Bradley's Nursery Stock.
Bradley's Orange and Lemon.
*Sulphate of Potash.

The Armour Fertilizer Works, Los Angeles, Cal.

Registration No. 7.

Armour's Bone, Blood and Potash.
Armour's Bone Meal.
Armour's Acidulated Bone Meal.
*Armour's Concentrated Superphosphate.
Dried Blood.
Armour's Fruit Special.
Armour's Fruit and Vine Fertilizer.
Armour's Lawn and Garden Fertilizer.
Nitrate of Soda.
Armour's Orange Tree Manure.
*Sulphate of Potash.
*Tankage.

Balfour, Guthrie & Co., San Francisco, Cal.

Registration No. 10.

*Muriate of Potash.
Nitrate of Soda.
Sulphate of Potash.
Thomas Phosphate Powder.

T. A. Blakely, San Bernardino, Cal.

Registration No. 15.

*Bone Meal.
Citrus Special A.
*Citrus Special B.
*Lemon.
*Meat Meal.
*Muriate of Potash.
*Nitrate of Soda.
*Sulphate of Potash.
*Treated Bone and Potash.

California Fertilizer Works, San Francisco, Cal.

Registration No. 3.

*Acid Phosphate.
*Blood.
*Fish Guano.
Fruit and Vine.
*Special Fruit and Vine.
Fruit, Orange and Vine.
High Grade Ammoniated Bone Superphosphate.
*High Grade Bone Meal.
*Lemon Tree (A).
*Lemon Tree (M).
*Muriate of Potash.
*Nitrate of Soda.
Nursery Stock.
Odorless Lawn Dressing.
*Orange Tree.
*Orange Tree (B).
*Orange Tree (C).
*Orange Tree (E).
*Orange Tree (O).
Special Orange Tree.
Peach.
*Sulphate of Ammonia.
*Sulphate of Potash.
*Tankage.
*Thomas Phosphate Powder.
Truck and Berry.

Cudahy Packing Co., South Omaha, Neb.

Registration No. 16.

*Cudahy's Regular Blood and Bone.

Charles S. Hardy, San Diego, Cal.
Registration No. 17.

Hardy's Tankage.

Hawaiian Fertilizer Co., Ltd., San Francisco, Cal.
Registration No. 19.

*(A).
*Nitrate of Soda.
*Sulphate of Potash.
*Thomas Phosphate Powder.

Thomas Lewis, Sacramento, Cal.
Registration No. 18.

The Lewis Fertilizer.

The Maier Fertilizer Co., Los Angeles, Cal.
Registration No. 6.

AA (Two formulas under the same name).
T (Two formulas under the same name).

Mapes Formula and Peruvian Guano Co., New York.
Registration No. 12.

Mapes Fruit and Vine Manure.
*Mapes Vegetable Manure.
Mapes Orange Tree Manure.

Mohr & Yoerk Packing Co., Sacramento, Cal.
Registration No. 21.

*Tankage, Slaughter House Refuse and Bones.

S. M. Neely, San Diego, Cal.
Registration No. 20.

Bird Guano.

N. Ohlandt & Co., San Francisco, Cal.
Registration No. 4.

*Bone Meal.
*Dissolved Bone Meal.
*Double Manure Salt.
*Double Superphosphate.
*Dried Blood.
Grape Fertilizer (00).
Kainit.
*Muriate of Potash.
Nitrate of Soda.
*Ohlandt's Lawn Dressing.
*Orange and Lemon (N).
*Orange and Lemon (NN).
Peach, Almond and Prune (0).
*Sulphate of Ammonia.
Sulphate of Potash.
Superphosphate.
Thomas Phosphate Powder.
Vegetable Grower (000).

Pacific Bone, Coal and Fertilizing Co., San Francisco, Cal.
Registration No. 14.

*AA.
*Acidulated Bone Meal.
*B.
*C.
*Double Superphosphate.
EE.
*Muriate of Potash.
*Nitrate of Soda.
Pure Bone Meal.
*Sulphate of Potash.
*Thomas Phosphate Powder.

Southern California Fertilizer Co., Ontario, Cal.
Registration No. 13.

*Animal Tankage.
*Double Superphosphate.
*Fruit and Vine.
*Ground Dried Blood.
*Ground Steamed Bone.
Lawn and Nursery.
*Nitrate of Soda.
Orange.
Orange Special.
Orange and Lemon.
*Root and Tuber Special.
*Sulphate of Potash.
*Superphosphate.

Swift & Co., Chicago, Ill.
Registration No. 5.

*Swift's Diamond "A" Fertilizer.
*Swift's Diamond "B" Fertilizer.
*Swift's Diamond "C" Fertilizer.
Swift's Diamond "D" Fertilizer.
Swift's Diamond "E" Fertilizer.
Swift's Diamond "G" Fertilizer.
Swift's Ground Dried Blood.
*Swift's Special Bone Meal.
*Swift's Special Acidulated Bone Meal.

Union Fertilizer Co., Los Angeles, Cal.
Registration No. 9.

Blood.
Bone Meal.
*Double Superphosphate.
Fruiting.
*Nitrate of Soda.
*Nursery.
Orange and Lemon.
*Sulphate of Potash.
*Tankage.

West Coast Fertilizer Works, Los Angeles, Cal.
Registration No 2.

*Blood.
*Dissolved Bone Phosphate.
Double Superphosphate.
*Lawn.
*Nitrate of Soda.
Special.
No. 3.
Standard.
*Sulphate of Potash.
*Tankage.

Western Meat Co., San Francisco, Cal.
Registration No. 11.

W. M. Co. Bone Meal.
W. M. Co. Tankage.

It will be seen from the foregoing list that 21 companies have registered 176 brands of fertilizers and fertilizing materials, which may be classified as follows:

Complete fertilizers	82
Bone meal and tankage	30
Dried blood	8
Fish and meat meal	2
Nitrate of soda and ammonium sulphate	14
Potash salts	20
Superphosphates	12
Thomas Phosphate Powder	5
Bird and bat guanos	3
Total	176

As required by Section 4 of the law, an inspection was made before September 1st (in August), which resulted in the collection of 70 samples. Eleven of these samples were not analyzed, some being materials to which the law did not apply, and others having been taken from old goods which the manufacturers agreed to ship back to the factory.

About three fourths of these samples were taken from remnants of goods that were put on the market before the law went into effect, and it was not thought worth while to issue a separate bulletin giving the analyses of these samples; but they are included in this report for comparison with goods that were put on the market after the law went into effect.

Another inspection, covering nearly the whole of the State, was made during the latter part of December and in January and February. This inspection resulted in the collection of 47 samples. Two of these samples were not analyzed, one being an unnecessary duplicate, and one a sample taken from only one bag, and hence not considered a fair sample. The small number of samples found on these two inspections is due to small sales of fertilizers caused by the prolonged drought in the southern part of the State, and to the poor prices of oranges.

In addition to the samples collected by the inspectors, 13 samples of registered materials were sent in by farmers. The total number of analyses of registered materials was 117, representing 82 brands and special formulas.

Three samples of miscellaneous fertilizing materials, not covered by the law, were analyzed, and these results are also reported.

ANALYSES FOR CONSUMERS.

Any user of fertilizers may, by paying the fee specified by Section 4 of the fertilizer law, have a sample of his material analyzed. This fee does not begin to pay the cost of the analysis, but the nominal charge is made to prevent the sending of samples through idle curiosity, as is always the case when analyses are made free of charge.

The sample should be drawn from the amount of fertilizer, and in the manner prescribed by Section 5 of the law, and whenever possible it should be drawn in the presence of the agent, who should sign, as a witness, the certificate given below. If the sample is not drawn in the presence of the agent, it should be done in the presence of some other person, who should sign the certificate as a witness. Special care should be exercised to thoroughly mix the large sample before drawing the small sample to send to the Station. This is absolutely necessary to obtain a trustworthy result. A sample filling a quart fruit jar is about the proper amount to send. Consumers' samples will be given prefer-

ence and the results reported as soon as possible. The sample should be sent in time to receive the report before the fertilizer is used, or else the bags from which the sample is taken should be reserved until the report is received, so that in case of controversy with the manufacturer an official sample may be drawn.

The form of certificate given below should be used in sending a sample for analysis. Blank forms will be furnished upon application. When more than one sample is sent, they should be marked in some way so that they may be identified. The samples should be sent prepaid, addressed to the Fertilizer Control, Experiment Station, Berkeley, and should bear the name and address of the sender. Bank checks and money orders should be made payable to "The Regents of the University of California." Letters, certificates and remittances should not be enclosed with the samples, but mailed separately. When the report is received, a tag or label taken from one of the bags sampled should at once be sent and the name and address of the agent from whom the goods were purchased should be given. Analyses will be made only for those who purchase fertilizers for their own use.

CERTIFICATE FOR CONSUMER'S ANALYSIS.

E. W. HILGARD, *Director*,
Berkeley, Calif.

This is to certify that I am not a dealer in, or agent for the sale of any fertilizer, and that the fertilizer, a sample of which I have sent you for analysis, was purchased by me ----------, 190--, for my own use and not for sale.

I further certify that the amount purchased was ------ tons, and that the sample was drawn from ------ packages and was thoroughly mixed.

Upon receipt of the analysis from you, I agree to furnish you with a tag or label taken from one of the packages sampled, and the name and address of the firm or agent of whom the fertilizer was purchased. I enclose two dollars analysis fee.

(Signature:) ----------

(P. O. Address:) ----------

(Signature of Witness:)

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EXPLANATION OF TERMS.

Phosphoric Acid.—The phosphoric acid used in fertilizers comes almost wholly from bone and phosphate rock. In bone the phosphoric acid is in combination with three parts* of lime, and it is chiefly in this form in phosphate rock. In most cases the bone and phosphate rock used have been acidulated (by means of sulfuric acid), giving rise to the product called superphosphate. The phosphoric acid in this product is found in three forms, namely, mono-calcium phosphate, in which the phosphoric acid is in combination with one part of lime; di-calcium phosphate (the so-called reverted phosphoric acid), in which the phosphoric acid is in combination with two parts of lime; and finally, a small percentage of the original material not affected by acidulation remains in the form of tri-calcium phosphate. Mono-calcium phosphate is soluble in water, and the di-calcium phosphate is soluble in a neutral solution of ammonium citrate. These forms are rated as available phosphoric acid. But the term "available" is not limited to these forms. It signifies all phosphates soluble in water and ammonium citrate. Raw bone is to some extent soluble in ammonium citrate, and steamed bone more so. The more finely the bone is ground the greater its solubility. In a mixed fertilizer, such a part of the insoluble phosphoric acid as is from bone is as valuable as if it were in bone meal of the same degree of fineness.

Any soluble phosphates that are applied to the soil become, in a short time, insoluble again by combining with lime and other elements of the soil. The question arises then, What is the use of applying soluble phosphates in the first place? When soluble phosphates are applied, they are carried in solution and evenly distributed in the soil and fixed in very *minute* particles. The availability of phosphates depends to a large extent upon their fineness. If bone and phosphate rock could be reduced to particles as minute as those that result from the fixation of soluble phosphates, and if this fine powder could be as evenly distributed, then it would perhaps not be worth while to render phosphates soluble.

Phosphoric acid in bone† meal becomes slowly available in the process of decay of the bone. As has already been suggested, steamed bone is more available than raw bone, and the degree of availability is influenced by the fineness of the bone.

Thomas Phosphate Powder† is another form of phosphate used to a considerable extent in this State. It is a by-product of the Bessemer process of refining steel, and is peculiar in that the phosphoric acid is in

*Chemical molecules.

†Available phosphoric acid is not determined in bone, tankage, and Thomas Phosphate Powder, but the degree of fineness of these materials is determined, as indicated further on.

combination with four parts of lime. There is also some caustic lime in the material. It usually contains from 16 to 20 per cent of phosphoric acid. Its availability is a somewhat mooted question in this State, although it is no longer a question in Europe, where tens of thousands of tons are used annually. It possesses the advantage that it can be reduced to a very fine powder. The proper way to settle the question of its availability is for each farmer to test it on his particular soil by comparing its effect with that of a superphosphate containing the same amount of phosphoric acid. The results produced and the cost of the materials should settle the matter.

The *percentage* of phosphoric acid expressed in fertilizer analysis signifies the amount of phosphorus pentoxid (P_2O_5) present.

Potash.—The *percentage* of potash, as used in fertilizer analysis, designates the equivalent of potassium oxid (K_2O) present. It is sometimes called "actual potash." Potash is not present in fertilizers as such, but almost wholly as the salts potassium sulfate and potassium chlorid ("muriate of potash"). In wood ashes it is in the form of potassium carbonate. Potash (K_2O) may be considered to exist in the sulfate (K_2SO_4) and in the carbonate (K_2CO_3), but not in the chlorid (KCl). All these salts are soluble in water and equally available, but when applied to the soil, the potash becomes fixed. Potassium chlorid is not considered as valuable as the sulfate or carbonate, for the reason that chlorin is injurious to some crops. The fixation of the potash liberates the chlorin, which in turn unites with elements of the soil and again forms soluble chlorids (of calcium and magnesium). Thus the chlorin is still in a form injurious to plants. When chlorin is present in other materials used in the fertilizer, its effect is the same; so it becomes quite necessary for the manufacturer to select materials as free as possible from chlorin.

But in this State there is another reason for guarding against the use of fertilizers containing an appreciable amount of chlorin, and that is that the soil is frequently heavily charged with alkali salts, about half of which are chlorids, and nowhere contains less than about ten times as much as soils in the East.

In the report of analyses, the percentage of chlorin is given when it exceeds 0.50 per cent; and when there is an amount present sufficient to combine with half or more of the potash, the potash is rated as derived from potassium chlorid (muriate) to the extent of the combining equivalent of the chlorin, whether it is in actual combination or not. This allowance is really too liberal, and may seem to open the way for the dishonest manufacturer to mix muriate with his sulfate: but it is assumed that the manufacturers are honest, and that when sulfate is claimed, sulfate has been used, and that any chlorin present

is from some other materials used. The microscope will, however, show whether or not fraud was attempted. Goods may be made practically free from chlorin, as will be seen by referring to the table of analyses.

Nitrogen.—Nitrogen is by far the most expensive ingredient in a fertilizer, and the most difficult to use properly. Phosphoric acid and potash become fixed in the soil, but this is not always so with nitrogen. There is always the danger of loss by leaching whenever nitrates are present. Unlike nitrates, ammonia is quite tenaciously retained by soils, very much as is potash, but gradually nitrifies, and then of course becomes subject to leaching out.

Nitrogen occurs in fertilizers in three forms, namely, in nitrates, in ammonia salts, and as organic nitrogen. Nitric nitrogen is derived almost exclusively from nitrate of soda (Chile saltpeter). This salt is soluble in water, and is at once available. Ammonium sulfate is the chief source of nitrogen in ammonia salts. This is also soluble in water, but not quite so widely available as nitrate of soda. It is not extensively used at present, on account of its high price. Some fertilizers contain a small percentage of nitrates and ammonia salts produced by conversion of organic nitrogen. Guanos contain both nitrates and ammonia salts produced in this way.

Organic nitrogen is found in almost every form of animal and plant growth, and varying in availability from that found in meat and blood, for example, to that found in leather, which is practically worthless. The chief sources of organic nitrogen in fertilizers are dried blood, tankage, bone, and fish scrap. Hair, hide, wool waste, leather, hoof, and horn are rich in nitrogen, but of low availability, and their use in fertilizers is forbidden by law, except with the explicit statement of the fact attached to every bag containing such materials.

Since nitrogen is such an expensive ingredient, and since California soils are so generally deficient in it, the greatest care and judgment should be used in the purchase of fertilizers containing it. The farmer should not only know how much nitrogen is present, and the materials from which it is derived, but he should know how much is present in each form, that is, how much each of nitric, ammoniacal, and organic nitrogen. If, for example, a fertilizer containing a large percentage of nitrogen in nitrate of soda should be applied to a sandy soil just before the rainy season begins, the nitrogen would be lost by leaching before the plant could use much of it. On the other hand, a fertilizer may be desired containing the nitrogen in this form in order to produce a quick growth in certain crops. Again, a fertilizer may be desired with just enough sodium nitrate in it to give the crop a start, and with the remainder of the nitrogen in organic or ammoniacal form which will become gradually available through a longer period of time. All these conditions make it necessary that the farmer know what he

is purchasing, and the farmer should require an explicit statement of the amount of each form in the fertilizer.

VALUATION OF FERTILIZERS.

The "agricultural value" and the "commercial value" of fertilizing materials are not synonymous terms. The agricultural value of a fertilizer is measured by the value of the increase in crop produced by its use. Nitrate of soda, one of the cheapest forms of nitrogen, produces on many crops, under proper conditions, a more profitable increase than the slower-acting forms; while on other crops, slower-acting and more expensive forms produce a more profitable increase. The commercial value is, of course, to some extent regulated by the agricultural value.

In calculating the values given in this report, the Station does not undertake to say what the retail prices of fertilizers should be in this State. The schedule of values used was adopted November 1, 1903, and represents, as nearly as could be determined at the time, the retail values, at centers of distribution like San Francisco, of phosphoric acid, nitrogen, and potash in raw materials of good quality. The values given for mixed goods do not take into account the cost of grinding, mixing, drayage, insurance, agent's commission, and other expenses of the manufacturer.

The following is the schedule of values used for calculating the values given in this report:

	Cents per Pound.
Phosphoric Acid.	
Available (soluble and reverted)	6
Insoluble in mixed fertilizers	2
In fine* bone and tankage	4½
In medium* bone and tankage	3½
In fine* Thomas Phosphate Powder	5†
In medium* Thomas Phosphate Powder	3†
Nitrogen.	
In ammonia salts	18
In nitrates	15½
Organic in—	
Blood	17½
Fish, meat, and mixed fertilizers	17
Fine* bone and tankage	16½
Medium* bone and tankage	12½
Potash.	
From sulphate	6
From muriate	5

* Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas Phosphate Powder by a 100-mesh sieve.

† These values and this separation are temporary, awaiting the adoption of methods by the Association of Official Agricultural Chemists. The values are based upon European practice.

Organic nitrogen in guanos is given a value depending upon the quality of the guano. For example, a bird or bat guano containing an abundance of feathers or insect wings would be given a low valuation upon its organic nitrogen.

To calculate the value of a fertilizer, multiply the value per pound of an ingredient by the percentage of the ingredient present, then multiply this result by 20. The sum of the results for all the ingredients is the value per ton. The term "unit" often used by fertilizer dealers signifies 20 pounds of an ingredient, or 1 per cent on the ton.

REPORT OF ANALYSES.

The following table gives the results of all analyses made to date. The star (*) before a sample indicates that it was taken from goods that were on the market before the law went into effect. "f" indicates that the sample was sent by a farmer. No goods were found to contain materials different from those claimed, except as indicated in the table.

The following abbreviations are used to designate materials used: Nit. = nitrate of soda; Bl. = blood; Bn. = bone; Am. Sul. = ammonium sulfate; Bat G. = bat guano; Bd. G. = bird guano; Fs. G. = fish guano*; T. = tankage.

Only those samples were analzyed for ammonia-nitrogen in which this form of nitrogen was guaranteed, or in which some material was used which was known to contain ammonia salts. Several tests were made on mixed fertilizers other than those mentioned, and the results obtained did not justify the time and labor required to make the tests. However, if any samples on which this test was not made, contained any ammonia-nitrogen, it will be included in the nitrate-nitrogen, and it has practically the same agricultural value. Hereafter, however, all samples will be analyzed for ammonia-nitrogen.

* Fish scrap.

ANALYSES AND VALUATIONS.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Value per Ton
	Agricultural Chemical Works, Los Angeles, Cal.		
87	Bat Guano	A. M. Seeley, Covina	$35.62
	Guaranteed		**22.90**
120	The Woodbridge Berry	Pioneer Fruit Co., Newcastle	23.25
	Guaranteed		**23.45**
6	*The Woodbridge Lawn	Patterson & Scott, Pomona	20.56
7	* do	Fletcher, Doyle & Co., San Diego	23.64
	Guaranteed		**18.75**
8	*Nitrate of Soda	Patterson & Scott, Pomona	49.60
	Guaranteed		**48.05**
11	The Woodbridge Orange and Lemon No. 1	Robert Gray, Ontario	30.88
12	* do	Fletcher, Doyle & Co., San Diego	26.05
88	do	A. M. Seeley, Covina	29.27
89	do	Manufacturers	30.24
	Guaranteed		**27.20**
9	The Woodbridge Orange and Lemon, for heavy soil	G. A. Herdeg, Riverside	22.43
92	do	A. M. Seeley, Covina	22.72
93	do	Manufacturers	23.71
	Guaranteed		**22.30**
90	The Woodbridge Orange and Lemon, for light soil	Manufacturers	24.12
91	do	A. M. Seeley, Covina	22.85
138	*f* do	F. S. Haupt, Redlands	22.64
	Guaranteed		**22.70**
135	The Woodbridge Orange and Lemon for non-fruiting trees	Fair Oaks Fruit Co., Fair Oaks	23.91
	Guaranteed		**22.65**
10	The Woodbridge Orange and Lemon, special formula	G. A. Herdeg, Riverside	22.52
	Guaranteed		**21.45**
121	The Woodbridge Orange and Lemon special formula	Pioneer Fruit Co., Newcastle	19.09
	Guaranteed		**18.05**
116	*f*The Woodbridge Peach	Frank Tupper, Newcastle	25.56
118	do	Pioneer Fruit Co., Newcastle	24.57
	Guaranteed		**23.90**
17	*Superphosphate	Fletcher, Doyle & Co., San Diego	22.69
	Guaranteed		**20.40**
94	Tankage	Manufacturers	29.49
	Guaranteed		**24.60**

ANALYSES AND VALUATIONS.

Laboratory Number	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin.
	Available.	Insoluble.	Total	Nitric	In Ammonia Salts	Organic	Total	Guaranteed as Derived From.	Muriate	Sulfate	Total	
87	5.51	0.26	5.77	2.65	2.01	3.64	8.30				0.89	
	4.00	**1.00**	**5.00**				**5.00**				**1.00**	
120	6.62	2.17	8.79	0.59		2.00	2.59			4.84		0.92
	6.00	**2.00**	**8.00**				**2.50**	Nit., Bl., Bn.		**6.00**		
6	4.11	4.57	8.68	0.55		2.62	3.17		3.18			3.02
7	5.21	4.08	9.29	0.54		2.95	3.49			3.38		
	5.00	**5.00**	**10.00**				**2.50**	Nit., Bl., Bn.	**2.50**			
8				16.00								
				15.50								
11	5.15	4.85	10.00	0.85		3.94	4.79	11, 12—Nit., Bl.,		5.60		1.04
12	4.40	5.32	9.72	1.15		2.90	4.05	Bn.	3.33	1.57	4.90	2.56
88	5.72	3.96	9.68	1.71		2.94	4.65	88, 89—Nit., Bl.,		4.61		0.80
89	6.58	2.92	9.50	1.75		2.86	4.61	Bn., Bat G.		5.02		0.68
	5.00	**5.00**	**10.00**				**4.00**			**5.00**		
9	4.64	5.87	10.51	1.29		2.03	3.32	9—Nit., Bl., Bn.		3.01		0.66
92	4.41	5.21	9.62	1.27		2.58	3.85	92, 93—Nit., Bl.,	1.85	0.66	2.51	1.42
93	6.52	5.05	11.57	0.81		2.17	2.98	Bn., Bat G.		3.32		0.74
	6.00	**4.00**	**10.00**				**3.00**			**3.00**		
90	6.47	3.05	9.52	1.32		1.86	3.18	90, 91—Nit., Bl.,		3.94		
91	5.48	4.29	9.77	1.21		1.91	3.12	Bn., Bat G.		3.59		
138	5.79	3.47	9.26	1.79		1.35	3.14	138—Nit., Bl., Bn.		3.47		0.60
	6.00	**2.00**	**8.00**				**3.00**			**4.00**		
135	7.52	5.44	12.96	1.19		1.73	2.92		1.60	1.28	2.88	1.24
	7.50	**4.50**	**12.00**				**2.50**	Nit., Bl., Bn.		**3.00**		
10	4.54	8.37	12 91	0.20		2.71	2.91			3.24		
	6.00	**6.00**	**12.00**				**2.50**	Nit., Bl., Bn.		**3.00**		
121	6.04	2.39	8.43	0.67		2.00	2.67			1.66		0.68
	6.00	**2.00**	**8.00**				**2.50**	Nit., Bl., Bn.		**1.50**		
116	7.35	1.24	8.59	0.97		2.22	3.19			4.73		0.64
118	6.93	1.29	8.22	0.98		2.16	3.14			4.46		0.64
	6.00	**2.00**	**8.00**				**3.00**	Nit., Bl., Bn.		**5.00**		
17	18.91	0.92	19.83									
	17.00	**1.10**	**18.10**									
94	13.33[1]	2.54[2]	15.87	4.16[1]	0.79[2]	4.95						0.80
			12.00			**5.00**						

[1] In fine Tankage. [2] In medium Tankage.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number...	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Value per Ton.....
	American Agricultural Chemical Co., Cal. Works, Los Angeles.		
27	Bradley's California Vegetable	W. R. Powell, Glendora	23.99
28	* do	Pacific Wood and Coal Co., San Diego	25.18
	Guaranteed		**25.69**
18	*Bradley's Fruit and Vine	Pacific Wood and Coal Co., San Diego	24.81
19	* do	J. R. Mattingly, Fresno	26.36
	Guaranteed		**24.37**
20	*Bradley's Special Fruit and Vine	Pacific Wood and Coal Co., San Diego	32.14
	Guaranteed		**32.35**
21	*Bradley's Lawn	Pacific Wood and Coal Co., San Diego	26.59
	Guaranteed		**26.53**
22	*Bradley's Nursery Stock	C. S. Spencer, Orange	25.76
23	do	Eben Boalt, Palermo	25.63
98	do	Graham-Cope Com'l Co., Redlands	26.87
99	do	Pacific Wood and Coal Co., San Diego	27.06
	Guaranteed		**26.53**
24	*Bradley's Orange and Lemon	W. R. Powell, Glendora	26.77
25	* do	Pacific Wood and Coal Co., San Diego	25.74
26	do	Eben Boalt, Palermo	25.88
100	do	Graham-Cope Com'l Co., Redlands	27.10
101	do	Pacific Wood and Coal Co., San Diego	26.26
	Guaranteed		**25.81**
	The Armour Fertilizer Works, Los Angeles, Cal.		
29	Armour's Bone, Blood, and Potash	H. B. Henderson, Riverside	33.28
	Guaranteed		**32.00**
30	*Armour's Bone Meal	H. Z. Adams, Orange	29.68
	Guaranteed		**26.70**
31	*Armour's Acidulated Bone Meal	H. B. Henderson, Riverside	28.99
	Guaranteed		**24.30**
32	*Dried Blood	H. B. Henderson, Riverside	48.83
	Guaranteed		**45.50**
33	*Armour's Fruit Special	H. Z. Adams, Orange	22.56
85	*f* do	Sunnyside Vineyard Co., Fresno	20.07
122	do	Producers' Fruit Co., Newcastle	21.70
	Guaranteed		**21.35**
123	Armour's Fruit and Vine Fertilizer	Producers' Fruit Co., Lodi	27.08
	Guaranteed		**26.60**
124	Armour's Lawn and Garden Fertilizer	Producers' Fruit Co., Lodi	24.38
	Guaranteed		**23.20**
34	Nitrate of Soda	Philip Rausch, Redlands	49.72
	Guaranteed		**46.50**
35	Armour's Orange Tree Manure	H. B. Henderson, Riverside	24.86
102	do	Manufacturers	28.14
125	do	Producers' Fruit Co., Newcastle	27.48
	Guaranteed		**25.10**

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.				Potash.			Chlorin
	Available.	Insoluble.	Total	Nitric	In Ammonia Salts	Organic	Total	Guaranteed as Derived From.	Muriate	Sulfate	Total	
27	8.00	1.58	9.58	2.98		0.48	3.46			2.41		
28	8.60	1.15	9.75	2.70		0.52	3.22	Bl., Bn., T., Bat		3.55		
	8.00	**1.00**	**9.00**				**3.30**	G., Fs. G., Nit.		**4.00**		
18	7.49	1.24	8.73	2.08		0.88	2.96			4.90		0.66
19	7.62	0.70	8.32	2.51		0.69	3.20	Bl., Bn., T., Bat		5.67		0.68
	7.00	**1.00**	**8.00**				**2.90**	G., Fs. G., Nit.		**5.00**		
20	6.92	0.76	7.68	2.83		0.85	3.68	Bl., Bn., T., Bat		9.90		0.70
	7.00	**1.00**	**8.00**				**3.50**	G., Fs. G., Nit.		**10.00**		
21	9.02	1.79	10.81	3.63		0.56	4.19	Bl., Bn., T., Bat		1.58		
	9.00	**1.00**	**10.00**				**4.10**	G., Fs. G., Nit.		**1.50**		
22	8.32	2 04	10.36	3.04		1.00	4.04			1.78		
23	8.34	3.18	11.52	2.09		1.78	3.87			1.52		
98	9.27	1.37	10.64	2.47		1.53	4.00			1.95		
99	8.96	1.71	10.67	2.66		1.54	4.20	Bl., Bn., T., Bat		1.78		
	9.00	**1.00**	**10.00**				**4.10**	G., Fs. G., Nit.		**1.50**		
24	8.86	3.10	11.96	3.05		0.64	3.69			2.72		
25	9.14	2.17	11.31	2.87		0.60	3.47			2 47		
26	8.34	2.33	10.67	2.87		0.75	3.62			2.91		
100	8.64	1.91	10.55	3.06		0.70	3.76			3.42		
101	8.06	2.22	10.28	2.86		0.89	3.75	Bl., Bn., T., Bat		3.17		
	8.00	**1.00**	**9.00**				**3.70**	G., Fs. G., Nit.		**3.00**		
29	6.20	2.70	8.90	2.25		2.57	4.82			7.53		0.72
	8.00	**2.00**	**10.00**				**4.00**	Bl., Bn., T., Nit.		**7.00**		
30	16.27[1]	11.55[2]	27.82	1.37[1]	0.97[2]	2.34						
			24.00			**2.50**						
31	15.87	5.26	21.13			2.31						
	15.00	**3.00**	**18.00**			**1.50**						
32							13.95					
							13.00					
33	6.93	3.02	9.95	1.02		1.52	2.54		3.74	0.80	4.54	2.88
85	7.00	3.14	10.14	0.46		1.36	1.82		4.36			3.60
122	8.00	2.68	10.68	0.30		1.53	1.83		4.90			3.80
	8.00	**2.00**	**10.00**				**1.50**	Nit., Bl., Bn., T.		**5.00**		
123	6.34	0.64	6.98	0.22		1.90	2.12			10.06		1.84
	6.00	**2.00**	**8.00**				**2.00**	Nit., Bl., Bn., T.		**10.00**		
124	4.19	0.70	4.89	trace		3.85	3.85			4.98		
	4.00	**1.00**	**5.00**				**4.00**	Nit., Bl., Bn., T.		**4.00**		
34				16.04								0.78
				15.00								
35	8.47	1.75	10.22	1.30		1.63	2.93			3.69		
102	8.34	3.13	11.47	1.64		2.02	3.66			4.11		
125	9.24	2.07	11.31	2.35	0.28	0.84	3.47			3.67		0.80
	8.00	**2.00**	**10.00**				**3.00**	Nit., Bl., Bn., T.		**4.00**		

[1] In fine Bone. [2] In medium Bone.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Value per Ton.
	Balfour, Guthrie & Co., San Francisco.		
126	Nitrate of Soda	B., G. & Co.'s Warehouse	48.05
	Guaranteed		**46.50**
37	*Sulphate of Potash	Beckman & Beattie, Lodi	59.95
	Guaranteed		**58.32**
2	*f*Thomas Phosphate Powder	H. F. Bracher, Cupertino	18.59
127	do	B., G. & Co.'s Warehouse	17.33
	Guaranteed		**17.89**
38	*Thomas Phosphate Powder	Salt Brothers, Oroville	15.92
	Guaranteed		**15.55**
	T. A. Blakely, San Bernardino, Cal.		
105	Citrus Special A	Manufacturer	36.73
	Guaranteed		**26.00**
	California Fertilizer Works, San Francisco, Cal.		
39	*Fruit and Vine	W. W. Gillett, Palermo	29.34
	Guaranteed		**26.65**
86	*f*Fruit, Orange, and Vine	Sunnyside Vineyard Co., Fresno	31.40
128	do	Sam Meyer, Healdsburg	31.33
	Guaranteed		**27.05**
82	*f*High Grade Ammoniated Bone Superphosphate	Geo. W. Hume, Los Gatos	30.27
	Guaranteed		**28.82**
40	*Nursery Stock	Jas. Feely, Red Bluff	30.24
	Guaranteed		**22.80**
129	Nursery Stock	Geo. D. Kellogg, Newcastle	29.57
130	do	Sam Meyer, Healdsburg	30.12
	Guaranteed		**26.50**
131	Odorless Lawn Dressing	Geo. D. Kellogg, Newcastle	22.71
	Guaranteed		**21.23**
132	Special Orange Tree	Geo. D. Kellogg, Newcastle	28.32
	Guaranteed		**24.65**
117	*f*Peach	Frank Tupper, Newcastle	30.61
119	do	Geo. D. Kellogg, Newcastle	31.41
	Guaranteed		**26.45**
134	Truck and Berry	Geo. D. Kellogg, Newcastle	30.60
	Guaranteed		**24.09**
133	Special Formula	Geo. D. Kellogg, Newcastle	33.13
	Guaranteed		**27.85**
137	*f*Special Formula	E. Clemens Horst Co., Perkins	30.28
	Guaranteed		**28.73**
	Chas. S. Hardy, San Diego, Cal.		
42	Hardy's Tankage	Manufacturer	31.88
	Guaranteed		**23.10**

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin.
	Available.	Insoluble.	Total.	Nitric.	In Ammonia Salts	Organic.	Total.	Guaranteed as Derived From.	Muriate.	Sulfate.	Total.	
126				15.50								
				15.00								
37										49.96		5.52
										48.60		
2	16.23[1]	3.93[2]	20.16									
127	14.88[1]	4.08[2]	18.96									
			19.45									
38	13.38[1]	4.23[2]	17.61									
			16.90									
105	9.20	3.56	12.76	0.25		3.94	4.19			8.41		
	5.00	**5.00**	**10.00**				**4.00**	Nit., Bl., Bn.		**4.00**		
39	7.03	1.42	8.45	1.72		0.93	2.65	Nit., Animal	7.04	4.00	11.04	5.42
	4.50	**2.50**	**7.00**				**2.50**	matter		**10.00**		
86	8.55	2.73	11.28	2.09		1.16	3.25			8.03		0.78
128	9.39	1.94	11.33	1.19	0.65	1.18	3.02	Nit., Animal		7.70		0.52
	8.00	**2.00**	**10.00**				**2.50**	matter		**7.00**		
82	10.91	8.36	19.27			4.07						
	14.00	**2.00**	**16.00**			**3.30**		Animal matter				
40	6.65	2.96	9.61	2.06		3.07	5.13	Nit., Animal	4.25			5.22
	5.00	**3.00**	**8.00**				**4.00**	matter		**2.00**		
129	8.59	2.56	11.15	2.45	0.74	1.33	4.52			2.88		0.60
130	8.49	2.69	11.18	2.67	0.72	1.33	4.72	Nit., Animal		2.88		
	8.00	**2.00**	**10.00**				**4.15**	matter		**2.00**		
131			13.53[3]	2.90						1.89		
			10.00	**3.30**						**1.50**		
132	8.92	2.26	11.18	1.38	0.49	0.94	2.81	Nit., Animal		6.23		0.74
	7.00	**2.00**	**9.00**				**2.50**	matter		**6.00**		
117	8.52	0.93	9.45	1.24	0.59	1.06	2.89			8.72		1.72
119	9.08	1.66	10.74	1.45	0.68	1.09	3.22	Nit., Animal		7.66		1.06
	7.00	**2.00**	**9.00**				**2.50**	matter		**7.50**		
134	9.83	3.01	12.84	1.99	0.62	1.30	3.91	Nit., Animal		3.98		0.84
	8.00	**3.00**	**11.00**				**3.30**	matter		**2.00**		
133	9.35	2.79	12.14	0.35	0.79	1.31	2.45	Nit., Animal		10.34		0.90
	8.00	**2.00**	**10.00**				**1.65**	matter		**10.00**		
137	4.97	2.07	7.04	1.34	0.20	1.87	3.41	Nit., Animal	12.26			12.48
	4.00	**3.00**	**7.00**				**3.25**	matter	**12.00**			
42	16.92[4]	3.71[5]	20.63	3.65[4]	0.80[5]	4.45						
			12.00			**4.50**						

[1] In fine Powder. [2] In medium Powder. [3] From Thomas Phosphate Powder.
[4] In fine Tankage. [5] In medium Tankage.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Value per Ton
	Thomas Lewis, Sacramento, Cal.		
81	*f* The Lewis Fertilizer	T. Reeves, Sacramento	19.47
114	do	Manufacturer	6.60
115	do	L. L. Crocker, Loomis	6.35
	Guaranteed		**18.32**
	The Maier Fertilizer Co., Los Angeles, Cal.		
43	AA	G. W. Dickson, Riverside	24.23
	Guaranteed		**24.70**
103	AA	Manufacturers	28.85
	Guaranteed		**27.20**
44	T	G. W. Dickson, Riverside	20.66
	Guaranteed		**20.30**
104	T	Manufacturers	24.53
	Guaranteed		**12.40**
	Mapes Formula and Peruvian Guano Co., New York.		
45	Mapes Fruit and Vine Manure	J. J. Prendergast, Redlands	28.61
	Guaranteed		**24.25**
46	Mapes Orange Tree Manure	J. J. Prendergast, Redlands	24.38
	Guaranteed		**22.86**
	S. M. Neely, San Diego, Cal.		
106	Bird Guano	S. M. Neely, San Diego	40.74
	Guaranteed		**33.72**
	N. Ohlandt & Co., San Francisco, Cal.		
54	*Acidulated Bone Black	F. R. Cook, San José	21.55
	Guaranteed		**19.35**
47	*Steamed Bone Meal	F. R. Cook, San José	28.37
	Guaranteed		**25.10**
48	*Grape Fertilizer (00)	F. R. Cook, San José	42.57
	Guaranteed		**39.80**
50	*Kainit	F. R. Cook, San José	12.69
	Guaranteed		**12.00**
51	*Nitrate of Soda	F. R. Cook, San José	45.94
	Guaranteed		**41.85**
52	*Peach, Almond and Prune (0)	F. R. Cook, San José	33.68
	Guaranteed		**26.90**
53	*Sulphate of Potash	F. R. Cook, San José	58.46
	Guaranteed		**57.60**
55	*Thomas Phosphate Powder	F. R. Cook, San José	17.43
	Guaranteed		**14.72**
56	*Vegetable Grower (000)	F. R. Cook, San José	40.89
	Guaranteed		**36.80**

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin
	Available.	Insoluble.	Total	Nitric	In Ammonia Salts	Organic	Total	Guaranteed as Derived From.	Muriate	Sulfate	Total	
81	3.98	1.25	5.23	0.57	------	0.97	1.54	------	------	7.60	------	0.74
114	1.80	0.32	2.12	------	------	------	1.05	------	------	0.62	------	----
115	2.01	0.27	2.28	------	------	------	0.98	------	------	0.42	------	----
	0.40	**6.60**	**7.00**	------	------	------	**3.50**	Sewage, Bl., Fs.	------	**2.75**	------	----
43	6.58	1.98	8.56	------	------	3.42	------	------	------	3.26	------	----
	7.00	**2.00**	**9.00**	------	------	**3.50**	------	Bl., Bn., T.	------	**3.00**	------	----
103	7.49	4.21	11.70	------	------	4.32	------	------	------	2.91	------	----
	7.00	**4.00**	**11.00**	------	------	**4.00**	------	Bl., Bn., T.	------	**3.00**	------	----
44	2.96	1.81	4.77	------	------	4.82	------	------	------	------	------	----
	3.50	**2.00**	**5.50**	------	------	**4.50**	------	Bl., Bn., T.	------	------	------	----
104	9.63	4.29	13.92	------	------	3.31	------	------	------	------	------	----
	4.00	**2.00**	**6.00**	------	------	**2.00**	------	Bl., Bn., T.	------	------	------	----
45	5.42	3.06	8.48	1.18	0.26	0.86	2.30	Nit., Animal	------	11.14	------	1.08
	5.00	**2.00**	**7.00**	------	------	------	**1.65**	matter	------	**10.00**	------	----
46	5.27	4.94	10.21	2.41	0.30	0.80	3.51	Nit., Animal	------	4.01	------	1.04
	6.00	**3.00**	**9.00**	------	------	------	**3.29**	matter	------	**3.00**	------	----
106	11.66	1.06	12.72	0.75	1.97	5.53	8.25	------	1.43	------	------	2.30
	8.86	**1.10**	**9.96**	------	------	------	**6.97**	------	------	------	**1.74**	----
54	12.10	12.40	24.50	------	------	0.61	------	------	------	------	------	----
	12.00	**12.38**	**24.38**	------	------	------	------	------	------	------	------	----
47	14.74[1]	10.68[2]	25.42	1.49[1]	1.08[2]	2.57	------	------	------	------	------	----
	------	------	**22.00**	------	------	**2.50**	------	------	------	------	------	----
48	12.08	5.07	17.15	------	------	2.61	------	------	------	14.31	------	0.64
	10.00	**2.00**	**12.00**	------	------	**3.00**	------	T.	------	**14.00**	------	----
50	------	------	------	------	------	------	------	------	12.69	------	------	31.86
	------	------	------	------	------	------	------	------	**12.00**	------	------	----
51	------	------	------	14.82	------	------	------	------	------	------	------	----
	------	------	------	**13.50**	------	------	------	------	------	------	------	----
52	8.25	5.82	14.07	2.95	------	0.36	3.31	------	------	9.23	------	0.52
	7.00	**2.00**	**9.00**	**3.00**	------	------	------	Nit.	------	**7.00**	------	----
53	------	------	------	------	------	------	------	------	------	48.72	------	1.90
	------	------	------	------	------	------	------	------	------	**48.00**	------	----
55	15.94[3]	2.49[4]	18.43	------	------	------	------	------	------	------	------	----
	------	------	**16.00**	------	------	------	------	------	------	------	------	----
56	13.27	3.92	17.19	1.69	------	2.31	4.00	------	------	8.59	------	0.54
	10.00	**2.00**	**12.00**	------	------	------	**4.00**	Nit., T.	------	**9.00**	------	----

[1] In fine Bone. [2] In medium Bone. [3] In fine Powder. [4] In medium Powder.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Value per Ton
	Pacific Bone, Coal and Fertilizing Co., San Francisco, Cal.		
83	*f*E E	Eggers Vineyard Co., San Francisco	31.16
	Guaranteed		**25.50**
136	Pure Bone Meal	Cox Seed Co., San Francisco	28.16
	Guaranteed		**25.10**
	Southern California Fertilizer Co., Ontario, Cal.		
57	*Lawn and Nursery	H. P. D. Kingsbury, Redlands	27.38
	Guaranteed		**28.10**
107	Lawn and Nursery	Manufacturers	31.55
	Guaranteed		**27.70**
58	Orange	H. P. D. Kingsbury, Redlands	31.59
	Guaranteed		**26.09**
108	Orange	Manufacturers	28.45
	Guaranteed		**24.49**
59	*Orange and Lemon	H. P. D. Kingsbury, Redlands	31.38
	Guaranteed		**26.55**
109	Orange Special	Manufacturers	32.48
	Guaranteed		**29.60**
	Swift & Co., Chicago, Ill.		
60	*Swift's Diamond "D" Fertilizer	C. B. Smith, Redlands	33.05
	Guaranteed		**32.15**
3	*f**Swift's Diamond "E" Fertilizer	Sweetwater Fruit Co., Bonita	30.33
	Guaranteed		**27.62**
61	*Swift's Diamond "E" Fertilizer	C. B. Smith, Redlands	33.07
	Guaranteed		**27.80**
63	*Swift's Diamond "G" Fertilizer	C. B. Smith, Redlands	31.18
	Guaranteed		**30.95**
62	*Swift's Ground Dried Blood	C. B. Smith, Redlands	49.32
	Guaranteed		**45.50**
	Union Fertilizer Co., Los Angeles, Cal.		
64	Blood	J. F. Jackson, Riverside	48.65
	Guaranteed		**42.00**
110	Bone Meal	Manufacturers	25.52
	Guaranteed		**26.60**
111	Fruiting	Manufacturers	33.19
	Guaranteed		**32.00**
67	Orange and Lemon	J. F. Jackson, Riverside	26.58
112	do	J. W. Freeman, Upland	29.46
113	do	Manufacturers	26.73
	Guaranteed		**24.50**

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin
	Available.	Insoluble.	Total	Nitric	In Ammonia Salts	Organic	Total	Guaranteed as Derived From.	Muriate	Sulfate	Total	
83	10.09	4.39	14.48	1.10	0.94	1.33	3.37	Bn., Nit., Am. Sul., T.		4.98		
	6.00	**6.00**	**12.00**				**3.00**			**5.00**		
136	10.76[3]	13.69[4]	24.45	1.37[3]	1.75[4]	3.12						
			22.00			**2.50**						
57	7.83	2.85	10.68	2.23		2.29	4.52			1.78		0.52
	8.00	**2.00**	**10.00**				**5.00**	Bn., T., Bl., Nit.		**1.00**		
107	8.21	1.72	9.93	2.29		3.31	5.60			2.22		0.66
	8.00	**1.00**	**9.00**				**5.00**	Nit., T., Bn.		**1.00**		
58	11.42	1.88	13.30	1.62		2.57	4.19			2.82		
	10.00	**2.00**	**12.00**				**3.30**	Bn., Bl., T., Nit.		**2.00**		
108	9.52	1.72	11.24	1.50		2.48	3.98			2.72		0.68
	9.00	**1.00**	**10.00**				**3.30**	Nit., T., Bn.		**2.00**		
59	12.20	1.45	13.65	1.61		2.25	3.86			2.93		0.58
	8.00	**3.00**	**11.00**				**3.50**	Bn., T., Bl., Nit.		**3.50**		
109	9.75	1.89	11.64	2.09		2.47	4.56			4.28		0.76
	10.00	**1.00**	**11.00**				**4.12**	Nit., T., Bn.		**3.00**		
60	12.56[1]	9.29[2]	21.85	1.34[1]	0.95[2]	2.29			8.45			8.68
			19.00			**1.65**		Bn., Bl., Meat		**10.00**		
3	7.73	10.56	18.29			5.61						0.78
			16.00			**4.94**		Animal matter				
61	14.13[1]	4.96[2]	19.09	4.04[1]	1.42[2]	5.46						0.64
			16.00			**5.00**		Bl., Bn.				
63	9.20[1]	8.15[2]	17.35	2.37[1]	2.11[2]	4.48			4.09			4.48
			19.00			**3.25**		Bl., Bn., T.		**5.00**		
62						14.09						
						13.00						
64						13.90						
						12.00						
110	3.93[3]	16.77[4]	20.70	0.73[3]	3.13[4]	3.86						
			22.00			**3.00**						
111	10.98	1.17	12.15	1.41	0.86	1.84	4.11			4.84		0.96
	10.00	**2.00**	**12.00**				**4.00**	Nit., Guano		**5.00**		
67	8.25	1.77	10.02	0.74	0.60	2.14	3.48			3.53		1.18
112	10.35	1.62	11.97	0.73	0.67	2.06	3.46			3.94		0.86
113	8.56	2.95	11.51	0.58	0.72	2.08	3.38			3.18		0.76
	8.00	**2.00**	**10.00**				**3.00**	Nit., T., Guano		**3.50**		

[1] In fine Bone and Tankage. [2] In medium Bone and Tankage.
[3] In fine Bone. [4] In medium Bone.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Value per Ton
	West Coast Fertilizer Works, Los Angeles, Cal.		
69	*Double Superphosphate	D. C. Twogood, Riverside	55.15
	Guaranteed		**57.60**
70	*No. 3	D. C. Twogood, Riverside	25.11
	Guaranteed		**24.25**
71	*Special	D. C. Twogood, Riverside	22.45
	Guaranteed		**24.25**
72	*Standard	D. C. Twogood, Riverside	24.08
	Guaranteed		**26.80**
4	*f* Special Formula	A. G. Hubbard, Redlands	23.08
	Guaranteed		**24.60**
	Western Meat Co., San Francisco, Cal.		
73	W. M. Co. Bone Meal	Manufacturers	31.08
	Guaranteed		**29.70**
74	W. M. Co. Tankage	Manufacturers	36.43
84	*f* do	W. H. Britton, Morgan Hill	37.49
	Guaranteed		**35.00**

MISCELLANEOUS FERTILIZING MATERIALS.

Sheep Manure.

Sample No. 75, sent by W. E. Sprott, Porterville—

Phosphoric acid	1.47%
Nitrogen	1.99
Potash	1.51

Wool Waste.

Sample No. 77, sent by Theodore Eder, Perkins—

Phosphoric acid	0.76%
Nitrogen	1.03
Potash	1.45

Street Sweepings.

Sample No. 79, sent by J. E. Woodruff, Redlands—

Phosphoric acid	0.51%
Nitrogen	0.31
Potash	0.18

It will be seen from the foregoing tables that nearly all goods sold in the State are pretty well up to guarantee. Especially is this true of the goods put on the market after the law went into effect. In some instances a brand has been short in one or two ingredients, but has had

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin.
	Available.	Insoluble.	Total.	Nitric.	In Ammonia Salts	Organic.	Total.	Guaranteed as Derived From.	Muriate.	Sulfate.	Total.	
69	45.96	0.32	46.28									
	48.00											
70	6.96	2.49	9.45	1.89		0.50	2.39			6.83		
	8.00	**1.00**	**9.00**				**2.50**	Bn., Bl., T., Nit.		**5.00**		
71	9.62	10.37	19.99	0.46		1.37	1.83			0.56		
	12.00	**1.00**	**13.00**				**2.50**	Bn., Bl., T., Nit.		**1.00**		
72	7.51	2.44	9.95	2.89		1.07	3.96			1.24		0.86
	10.00	**1.00**	**11.00**				**4.00**	Bn., Bl., T., Nit.		**1.00**		
4	10.92	1.20	12.12				0.34			6.95		
	13.00		**13.00**							**7.50**		
73	9.25[1]	15.76[2]	25.01	1.55[1]	2.64[2]	4.19						
			24.00			**3.50**						
74	7.62[3]	1.91[4]	9.53	7.19[3]	1.80[4]	8.99						
84	6.97[3]	1.91[4]	8.88	7.50[3]	2.05[4]	9.55						
			10.00			**9.00**						

[1] In fine Bone. [2] In medium Bone. [3] In fine Tankage. [4] In medium Tankage.

a compensating excess in the other ingredient or ingredients, which made the value on the analysis equal to or greater than the value on the guarantee. This does not indicate any dishonesty on the part of the manufacturer, but indicates poor mixing. It is gratifying to note that, as a class, the manufacturers doing business in the State are meeting their guarantees, and to all such the fertilizer law is a protection.

REPORT OF SALES.

The reports of sales required by Section 8 of the law showed the following for the first two quarters of the fiscal year:

Quarter ending September 30, 1903	1,404 tons.
Quarter ending December 31, 1903	1,451 tons.

The reports for the third quarter are not all in as this report goes to press, but the indications are that the sales will be approximately 4,000 tons.

As has already been suggested, the fertilizer dealers give two reasons for these small sales, namely, the prolonged drought in southern California, and the poor prices received for the orange crop.

ECONOMY IN THE USE OF HIGH-GRADE FERTILIZERS.

Farmers are advised to use fertilizers containing a high percentage of ingredients, for the reason that they are cheaper. A comparison of the following formulas will show why this is true. Suppose, for example, a fertilizer of this low-grade composition is offered:

Phosphoric acid	6% =	600 lbs. 20% superphosphate.
Nitrogen	2% =	275 lbs. blood and nitrate of soda.
Potash	3% =	125 lbs. sulfate of potash.
Total materials used		1,000 lbs.
Filler required to make out the ton		1,000 lbs.

Another of this higher-grade composition is offered:

Phosphoric acid	12% =	1,200 lbs. 20% superphosphate.
Nitrogen	4% =	550 lbs. blood and nitrate of soda.
Potash	6% =	250 lbs. sulfate of potash.
Total materials used		2,000 lbs.
No filler required.		

Supposing the second formula to cost twice as much as the first, money will be saved by buying the second; because, for the same amount of plant-food, only one half of the second would be needed per acre, and this would require but one half of the freight charges and one half the time spent in handling. Nor is this all. The filler is worthless to the farmer, but it costs the fertilizer manufacturer as much to mix and handle the filler as it does the fertilizing materials themselves, and he charges for the expense. Farmers have been heard to exclaim in surprise and disgust that they have seen fertilizers that actually contained sawdust, cinders, sand, etc. No doubt they have. The manufacturer is at liberty to use anything for a filler he chooses, so long as it is not an injurious material. The farmer himself is responsible for low-grade goods. He demands a fertilizer at a low price per ton, and the filler is absolutely necessary, but he is paying a very high price for the actual plant-food contained. If the farmer wants high-grade goods the manufacturers will gladly make them.

THE NEW FERTILIZER LAW.

The California fertilizer law is fully abreast of the times in its provisions. Its distinguishing feature is the requirement that the sources of the ingredients be stated on the labels. The wonder is that all State laws have not required this, but as a matter of fact only a few have done so. But this feature is more important in California than in any other State having a fertilizer law. As was suggested in the discussion of nitrogen, the nature of the climate and soil here make it highly necessary that the farmer know just what materials he is using. The Fertilizer Control is endeavoring to require the manufacturer to state

not only the total percentage of nitrogen and the materials from which it is derived, but also the amount present each of nitric, ammoniacal, and organic nitrogen. The law clearly warrants this construction, and it is what was specially intended by its framers. Whether or not the Fertilizer Control is successful in carrying out the requirement, the consumers of fertilizers should demand this knowledge. Opposition to the requirement has come from only a very limited number of manufacturers, and the chief objection urged is that it would require the manufacturer to give away his secrets. This is not true, however. It is only required that the manufacturer give the information on the manufactured goods, and does not require him to state a single fact as to the *process* of manufacture.

The statement has been made that the farmer does not care to know of what materials his goods are made, and that he, as a rule, wants to leave the matter of selecting fertilizers for his crops to the manufacturer. There may be a few farmers so averse to thinking for themselves that they want to do this, but it is to be hoped that at least ninety-nine per cent of the farmers in California are progressive enough to want to know why they use this or that formula; and to know this, requires that they shall know the full composition of the fertilizer, and what part each component in the fertilizer plays. It would be a hopeless state of affairs if our farmers were willing to commit themselves to that practice, no matter how honest the manufacturers may be, and settle down into a state of "blissful ignorance." Such a placid resignation of the exercise of judgment on the part of the farmers would preclude the necessity for a fertilizer law, and the principle carried to its logical conclusion would also render nugatory many of the other efforts of the Agricultural College and the Experiment Station to familiarize farmers with the principles of rational agriculture.

The Station has not the slightest desire to array the farmer against the manufacturer. It is its purpose to see that both sides get fair treatment, and it will always stand on this ground. There should be confidence between the two, but it should be a confidence born of intelligence, and not of blind faith.

THE LABELING OF FERTILIZER PACKAGES.

To be properly labeled each bag or package of fertilizer should bear the following information, which may be upon a tag attached to the bag or it may be printed on the bag, provided it is plainly done:

The name and address of the manufacturer, and place of manufacture.

The name or brand of fertilizer.

"Registered" No.....

A chemical analysis, giving the percentages of essential ingredients.

A statement of the materials from which the essential ingredients are derived.

REPORTS AND BULLETINS AVAILABLE FOR DISTRIBUTION.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1898. Partial Report of Work of Agricultural Experiment Station for the years 1895-96 and 1896-97.
1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.

BULLETINS.

No. 121. The Conservation of Soil Moisture and Economy in the Use of Irrigation Water.
125. Australian Saltbush.
127. Bench-Grafting Resistant Vines.
128. Nature, Value, and Utilization of Alkali Lands.
129. Report of the Condition of Olive Culture in California.
131. The Phylloxera of the Vine.
132. Feeding of Farm Animals.
133. Tolerance of Alkali by Various Cultures.
134. Report of Condition of Vineyards in Portions of Santa Clara Valley.
135. The Potato-Worm in California.
136. Erinose of the Vine.
137. Pickling Ripe and Green Olives.
138. Citrus Fruit Culture.
139. Orange and Lemon Rot.
140. Lands of the Colorado Delta in Salton Basin, and Supplement.
141. Deciduous Fruits at Paso Robles.
142. Grasshoppers in California.
143. California Peach-Tree Borer.
144. The Peach-Worm.
145. The Red Spider of Citrus Trees.
146. New Methods of Grafting and Budding Vines.
147. Culture Work of the Substations.
148. Resistant Vines and their Hybrids.
149. California Sugar Industry.
150. The Value of Oak Leaves for Forage.
151. Arsenical Insecticides.
152. Fumigation Dosage.
153. Spraying with Distillates.
154. Sulfur Sprays for Red Spider.
155. Directions for Spraying for the Codling-Moth.
156. Fowl Cholera.

CIRCULARS.

No. 1. Texas Fever.
2. Blackleg.
3. Hog Cholera.
4. Anthrax.
5. Contagious Abortion in Cows.
6. Methods of Physical and Chemical Soil Analysis.
7. Remedies for Insects.
8. Laboratory Method of Water Analysis.
9. Asparagus Rust.
10. Reading Course in Economic Entomology.
11. Fumigation Practice.

Copies may be had by application to the Director of the Experiment Station, Berkeley, California.

24/7/05

UNIVERSITY OF CALIFORNIA PUBLICATIONS.

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AGRICULTURAL EXPERIMENT STATION.

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GEORGE E. COLBY, M.S., *Assistant Chemist.* (*Fruits, Waters, Insecticides.*)
RALPH E. SMITH, B.S., *Plant Pathologist.*
A. R. WARD, B.S.A., D.V.M., *Veterinarian, Bacteriologist.*
E. H. TWIGHT, B.Sc., Diplomé E.A.M., *Viticulturist.*
E. W. MAJOR, B.Agr., *Animal Industry.*
A. V. STUBENRAUCH, M.S., *Assistant Horticulturist, in charge of Substations.*
WARREN T. CLARKE, B.S., *Assistant Field Entomologist.*
H. M. HALL, M.S., *Assistant Botanist.*
H. J. QUAYLE, A.B., *Assistant Entomologist.*
GEORGE ROBERTS, M.S., *Assistant Chemist, in charge Fertilizer Control.*
C. M. HARING, D.V.M., *Assistant Veterinarian and Bacteriologist.*
C. A. TRIEBEL, Ph.G., *Assistant in Agricultural Laboratory.*
C. A. COLMORE, B.S., *Clerk to the Director.*

R. E. MANSELL, *Foreman of Central Station Grounds.*
JOHN TUOHY, *Patron,*
JULIUS FORRER, *Foreman,* } Tulare Substation, Tulare.
J. E. McCOMAS, *Patron,* Pomona,
J. W. MILLS, *Superintendent,* Pomona,
In charge Cooperation Experiments of Southern California,
JOHN H. BARBER, *Assistant Superintendent,* Ontario, } Southern California Substation.
J. W. ROPER, *Patron,*
HENRY WIGHTMAN, *In charge,* } University Forestry Station, Chico.
ROY JONES, *Patron,*
WM. SHUTT, *Foreman,* } University Forestry Station, Santa Monica.
H. O. WOODWORTH, M.S., *Foreman of Poultry Station,* Petaluma.

The Station publications (REPORTS AND BULLETINS), *so long as available, will be sent to any citizen of the State on application.*

COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

Registrations.—Below is given a list of manufacturers of, and dealers in, commercial fertilizers who have obtained certificates of registration under the provisions of the California fertilizer law for the year beginning July 1, 1904. A list is also given of the brands of fertilizers and fertilizing materials offered for sale by the registered dealers.

The star (*) preceding a brand signifies that the fertilizer inspector was unable to find a sample on the market or in the manufacturer's warehouse when the inspection herein reported was made.

Agricultural Chemical Works, Los Angeles, Cal.

Registration No. 8.

*Apricot.
*Bat Guano.
*Berry.
*Blood Meal.
*Fine Ground Bone.
*Grape.
Gypsum.
Lawn.
*Peach.
*Muriate of Potash.
*Nitrate of Soda.
No. 1 Lemon.
No. 1 Orange and Lemon.
*Nursery.
*Olive.
*Potato.
*Prune.
*Rose.
Special Orange and Lemon for Heavy Soil.
Special Orange and Lemon for Light Soil.
*Special Orange and Lemon for Non-fruiting Trees.
*Sulfate of Potash.
*Superphosphate.
*Double Superphosphate.
Tankage.
*Vegetable.
*Walnut and Almond.

American Agricultural Chemical Co., California Works, Los Angeles, Cal.

Registration No. 1.

*Acid Phosphate.
*Bradley's Fruit and Vine.
*Bradley's Special Fruit and Vine.
Bradley's Lawn.
*Nitrate of Soda.
Bradley's Nursery Stock.
Bradley's Orange and Lemon.
*Sulfate of Potash.
*Bradley's Vegetable.

The Armour Fertilizer Works, Los Angeles, Cal.

Registration No. 7.

*Armour's Acidulated Bone Meal.
Armour's Bone Meal.
Armour's Bone, Blood and Potash.
*Concentrated Superphosphate.
Armour's Dried Blood.
Armour's Fruit Special.
Armour's Fruit and Vine.
Armour's Lawn and Garden Fertilizer.
Nitrate of Soda.
Armour's Orange Tree Manure.
*Armour's Special 582.
*Sulfate of Potash.
*Armour's Tankage.

Balfour, Guthrie & Co., San Francisco, Cal.

Registration No. 10.

*Muriate of Potash.
*Nitrate of Soda.
*Sulfate of Potash.
Thomas Phosphate Powder.

California Fertilizer Works, Inc., San Francisco, Cal.

Registration No. 3.

*Blood.
*Double Manure Salt.
*Fish.
Fruit and Vine.
*Special Fruit and Vine.
Fruit, Orange and Vine.
*High Grade Ammoniated Bone Superphosphate.
*High Grade Bone Meal.
*Hops.
*Lemon Tree (M).
*Muriate of Potash.
Nitrate of Soda.
Nursery.
*Odorless Lawn Dressing.
*Orange and Lemon.
*Orange Tree.
*Orange Tree B.
*Special Orange Tree.
*Peach.
*Special Fertilizer with Iron Sulfate
*Sulfate of Ammonia.
Sulfate of Potash.
*Tankage.
Thomas Phosphate Powder.
*Truck and Berry.
*Special Fertilizer No. 1.
*Special Fertilizer No. 2.
*Special Fertilizer No. 3.
*Special Fertilizer No. 4.
*Special Fertilizer No 5.
*Special Fertilizer No. 6.

Cudahy Packing Co., South Omaha, Neb.

Registration No. 16.

*Cudahy's Blood and Bone.

Chas. S. Hardy, San Diego, Cal.

Registration No. 17.

Hardy's Tankage.

Hawaiian Fertilizer Co., Ltd., San Francisco, Cal.

Registration No. 19.

*Bone Meal.
*Muriate of Potash.
*Nitrate of Soda.
*Sulfate of Potash.
*Thomas Phosphate Powder.

The Maier Fertilizer Co., Los Angeles, Cal.

Registration No. 6.

"AA" (four formulas under same name).
"T" (four formulas under same name).

Mapes Formula and Peruvian Guano Co., New York.

Registration No. 12.

*Mapes Fruit and Vine Manure.
Mapes Orange Tree Manure.

Mohr & Yoerk Packing Co., Sacramento, Cal.

Registration No. 21.

M. and Y.

S. M. Neely, San Diego, Cal.

Registration No. 20.

Bird Guano.

N. Ohlandt & Co., San Francisco, Cal.

Registration No. 4.

*Dissolved Bone Meal.
*Raw Bone Meal.
*Steamed Bone Meal.
*Double Manure Salt.
*Dried Blood.
*Fish Scrap.
*(OO) Grape Fertilizer.
*Kainit.
Ohlandt's Lawn Dressing.
*Muriate of Potash.
*Nitrate of Soda.
*(N) Orange and Lemon.
*(NN) Orange and Lemon.
*(O) Peach, Almond and Prune.
*Sulfate of Ammonia.
*Sulfate of Potash.
*Superphosphate.
*Double Superphosphate.
*Tankage No. 1.
*Tankage No. 2.
*Thomas Phosphate Powder.
*(OOO) Vegetable Grower.

Pacific Bone, Coal and Fertilizing Co., San Francisco, Cal.

Registration No 14.

*Acidulated Bone Meal.
*Ammoniated Dissolved Bone Meal.
*Pure Dissolved Bone Meal.
*Pure Bone Meal.
*"Ceres" Brand.
*"Citrone" Brand.
*Double Superphosphate.
*Muriate of Potash.
*Nitrate of Soda.
*"Pomona" Brand.
*Sulfate of Potash.
*"Supine" Brand.
*Thomas Phosphate Powder.

Southern California Fertilizer Co., Ontario, Cal.

Registration No. 13.

*Animal Tankage.
*Double Superphosphate.
Fruit and Vine.
*Ground Dried Blood.
*Ground Steamed Bone.
Lawn and Nursery.
*Nitrate of Soda.
Orange.
Orange Special.
*Orange and Lemon.
*Root and Tuber Special.
*Sulfate of Potash.

Swift & Co., Chicago, Ill.

Registration No. 5.

Swift's Diamond "A" Fertilizer.
*Swift's Diamond "B" Fertilizer.
*Swift's Diamond "C" Fertilizer.
*Swift's Diamond "D" Fertilizer.
Swift's Diamond "E" Fertilizer.
Swift's Diamond "G" Fertilizer.
Swift's Ground Dried Blood.
Swift's Special Acidulated Bone.
Swift's Special Bone Meal.

Union Fertilizer Co, Los Angeles, Cal.

Registration No. 9.

*Blood.
Bone Meal.
*Double Superphosphate.
Fruiting Fertilizer.
Special Fruiting Fertilizer.
*Lawn Fertilizer.
Nursery Fertilizer.
Orange and Lemon Fertilizer.
*Sulfate of Potash.
*Tankage.

Western Meat Co., San Francisco, Cal.

Registration No. 11.

*W. M. Co. Bone Meal.
W. M. Co. Tankage.

The Woodbridge Chemical Co., San Bernardino, Cal.

Registration No. 15.

*Apricot.
*Bat Guano.
*Blood.
*Bone Meal.
*Citrus A.
*Citrus B.
*Grape.
*Hoof Meal.
*Lemon.
*Muriate of Potash.
*Nitrate of Soda.
*Orange and Lemon No. 1.
*Peach and Prune.
*Rose Fertilizer.
*Sulfate of Potash.
*Tankage.
*Vegetable Fertilizer.
*Vegetable Fertilizer for Leguminous Crops.
*Walnut and Almond.

Summarizing the foregoing list, it will be seen that 19 companies have registered 190 brands, which may be classified as follows:

Complete Fertilizers	87
Bone Meal, Tankage, and Fish	34
Nitrogenous Superphosphates	10
Dried Blood	8
Nitrate of Soda	10
Ammonium Sulfate	2
Potash Salts	21
Superphosphates	9
Thomas Phosphate Powder	5
Bird and Bat Guanos	3
Gypsum	1
Total	190

The West Coast Fertilizer Co., which was registered last year, is out of business this year, but some of its goods are yet on the market, a sample of which was collected and analyzed and is herein reported.

Following the requirements of Section 4 of the fertilizer law, which requires that an inspection be made between July 1st and September 1st, an inspection covering the State was made in August. Seventy-five samples were collected on this inspection, all of which were analyzed and are reported in this bulletin, with one exception, a sample taken from a stock of only two bags, and for this reason not considered a representative sample. In addition to these samples collected by the inspector, six samples have been sent by farmers for analysis since the last bulletin on fertilizers was issued, and these results are also given.

The samples included in this report may be classified as follows:

Complete Fertilizers	50
Bone Meal and Tankage	12
Nitrogenous Superphosphates	4
Nitrate of Soda	2
Sulfate of Potash	2
Bird Guano	2
Gypsum	2
Thomas Phosphate Powder	3
Blood	3
Total	80

These 80 samples represent 54 registered fertilizers, fertilizing materials, and special formulas. These numbers will doubtless impress most readers of this report as being small when it is remembered that 190 brands and materials have been registered; and so they are. Experience has shown that between July 1st and September 1st practically all the goods found on the market are remnants of the preceding spring trade. The law does not prohibit other inspections, and the State will be thoroughly inspected again each year at such a time as circumstances indicate that the largest amount of goods will be found on the market. The plan of inspection is to get as many samples as possible from goods actually on the market. After having secured samples of as many brands as possible in this way, the inspector then visits the factories and endeavors to secure samples of the brands not found in the hands of agents. Notwithstanding this procedure, many brands are registered which are not found on the market or in the factory. The fact is that the trade in fertilizers is limited to a few standard brands. The inference is that many of the brands are advertised to meet the supposed needs of farmers, but are made up only as orders are received.

Two reports will be issued each year. The first will give the results of the inspection made prior to September 1st, and the second the results of the subsequent inspections made during the winter and spring seasons. The reports will be distributed as soon after the analyses are

finished as it is possible to get them through the press. The first may be looked for about December, and the second about May or June.

DEFICIENCIES.

Section 4 of the fertilizer law provides that "Whenever the analysis certified by the said Director shall show a deficiency of not more than one fourth of one per cent of nitrogen, or one per cent of soluble or available phosphoric acid, or one half of one per cent of potash soluble in distilled water, the statement of the manufacturer or importer, as required in section one of this Act, shall not be deemed to be false in the meaning of this Act."

The following summary gives the average guaranteed composition of the samples containing two or more ingredients, the average of the analyses of the same, and the number of deficiencies found:

Average of Guaranteed Composition.

Available Phosphoric Acid	8.08%
Insoluble Phosphoric Acid	2.07%
Total Phosphoric Acid	11.62%
Nitrogen	3.66%
Potash	3.76%

Average Composition of the above Samples as shown by the Analysis.

		Excess above Guarantee.
Available Phosphoric Acid	8.72%	0.64%
Insoluble Phosphoric Acid	2.13%	0.06%
Total Phosphoric Acid	11.98%	0.36%
Nitrogen	3.92%	0.26%
Potash	3.91%	0.15%

Out of 80 samples, 60 are within the limits of deficiency allowed by law in all the ingredients, although some fall somewhat below the guarantee in one or more ingredients. Five fall below the legal allowance in available phosphoric acid, nine in nitrogen, and eight in potash. Several samples have a shortage in one or more ingredients and have a compensating excess in the other ingredient or ingredients, so that the value calculated from the analysis is equal to or greater than the value calculated upon the guarantee.

The average value for all the samples calculated upon the guarantee is $28.68, while the average value calculated upon the analysis is $30.21.

In estimated value, only one sample is deficient in an amount greater than the value of the deficiencies allowed by law.

ANALYSES FOR CONSUMERS.

Any user of fertilizers may, by paying the fee specified in Section 4 of the fertilizer law, have a sample of his material analyzed. This fee

does not begin to pay the cost of the analysis, but the nominal charge is made to prevent the sending of samples through idle curiosity, as is always the case when analyses are made free of charge.

The sample should be drawn from the amount of fertilizer, and in the manner prescribed by Section 5 of the law, and whenever possible it should be drawn in the presence of the agent, who should sign, as a witness, the certificate given below. If the sample is not drawn in the presence of the agent, it should be done in the presence of some other person, who should sign the certificate as a witness. Special care should be exercised to thoroughly mix the large sample before drawing the small sample to send to the Station. This is absolutely necessary to obtain a trustworthy result. A sample filling a quart fruit jar is about the proper amount to send. Consumers' samples will be given preference and the results reported as soon as possible. The sample should be sent in time to receive the report before the fertilizer is used, or else the bags from which the sample is taken should be reserved until the report is received, so that in case of controversy with the manufacturer an official sample may be drawn.

The form of certificate given below should be used in sending a sample for analysis. Blank forms will be furnished upon application. When more than one sample is sent, they should be marked in some way so that they may be identified. The sample should be sent prepaid, addressed to the Fertilizer Control, Experiment Station, Berkeley, and should bear the name and address of the sender. Bank checks and money orders should be made payable to "The Regents of the University of California." Letters, certificates, and remittances should not be enclosed with the samples, but mailed separately. When the report is received, a tag or label taken from one of the bags sampled should at once be sent and the name and address of the agent from whom the goods were purchased should be given. Analyses will be made only for those who purchase fertilizers for their own use.

CERTIFICATE FOR CONSUMER'S ANALYSIS.

E. W. HILGARD, *Director*,
Berkeley, Calif.

This is to certify that I am not a dealer in, or agent for the sale of any fertilizer, and that the fertilizer, a sample of which I have sent you for analysis, was purchased by me ----------, 190- , for my own use and not for sale.

I further certify that the amount purchased was ------ tons, and that the sample was drawn from ------ packages and was thoroughly mixed.

Upon receipt of the analysis from you, I agree to furnish you with a tag or label taken from one of the packages sampled, and the name and

address of the firm or agent of whom the fertilizer was purchased. I enclose two dollars analysis fee.

(Signature:)----------

(P. O. Address:)----------

(Signature of Witness:)

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An explanation of terms used in reporting fertilizer analyses was given in Bulletin No. 157, and will not be repeated here. The text of the law was also given in the same bulletin. Those who have not obtained a copy of the bulletin may do so by addressing the Director of the Experiment Station, Berkeley, Calif.

VALUATION OF FERTILIZERS.

The "agricultural value" and the "commercial value" of fertilizing materials are not synonymous terms. The agricultural value of a fertilizer is determined by the increase and quality produced by it in the crop. The commercial value of a fertilizer is determined by the cost of the materials which enter into its composition. A fertilizing material may have a low agricultural value on a particular soil and have a high commercial value. On another soil the same material may have a high agricultural value.

Nitrate of soda, at present one of the cheapest forms of nitrogen, produces on some crops the more profitable increase, while on other crops the slower-acting and more expensive forms produce the more profitable increase.

The law of supply and demand regulates the commercial value of fertilizing materials, the *general* agricultural value of the materials regulating largely, of course, the general demand for them.

In calculating the values given in this report, the Experiment Station does not undertake to say what the retail prices of fertilizers should be in this State. The values given are for the unmixed raw materials which enter into the fertilizer, and do not take into account the cost of grinding, mixing, bagging, insurance, drayage, agents' commissions, and other expenses of the manufacturer.

The schedule of values used is given below. They represent as nearly as could be determined the prices at which fertilizing ingredients in raw

materials of good quality could be bought at retail for cash at the warehouse in our largest markets like San Francisco. Quotations were called for from dealers, but they varied so widely that it was very difficult to arrive at a schedule of values that represent the actual market conditions. Two values are given for each sample analyzed, one calculated on the guarantee, and the other on the actual analysis. Even if the trade values are not absolutely correct, they serve as a basis for comparison between the guarantee and the analysis.

SCHEDULE OF TRADE VALUES.

	Cents per Pound.
Phosphoric Acid.	
Available (soluble and reverted)	6
Insoluble in mixed fertilizers	2½
In fine* bone and tankage	4½
In medium* bone and tankage	3½
In fine* Thomas Phosphate Powder	5¼†
In medium* Thomas Phosphate Powder	3¼†
Nitrogen.	
In ammonia salts	18
In nitrates	15½
Organic in—	
Blood	18
Fish, meat, and mixed fertilizers	17½
Fine* bone and tankage	17
Medium* bone and tankage	14
Potash.	
From sulfate	6
From muriate	5

To illustrate the method of calculating the value of a fertilizer, the following example is given:

	Guaranteed Analysis.	Value per lb.	
Available Phosphoric Acid	8.00 % @	6 cents =	$0.48
Insoluble Phosphoric Acid	2.00 % @	2½ cents =	0.05
Total Phosphoric Acid	10.00		
Nitrogen in Nitrates	1.50 % @	15½ cents =	0.23¼
Nitrogen in Organic Matter	2.50 % @	17½ cents =	0.43¾
Total Nitrogen	4.00		
Potash from Sulfate	4.00 % @	6 cents =	0.24
Value			$1.44 per 100 lbs.

$1.44 × 20 = $28.80 per ton.

It is to be hoped that farmers will carefully examine the analyses instead of looking only at the column of commercial values. The agricultural value of a fertilizer depends upon the amount and proportions

*Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas Phosphate Powder by a 100-mesh sieve.

† This method of giving a valuation to Thomas Phosphate Powder is temporary, awaiting the adoption of methods by the Association of Official Agricultural Chemists.

of the essential ingredients contained in forms available to plants, and the materials from which they are derived. The value calculated upon the analysis may be greater than the value calculated upon the guarantee, and at the same time one ingredient be much below guarantee, while another is correspondingly above guarantee. It is desirable that the fertilizer be as evenly mixed as possible.

REPORT OF ANALYSES.

The following table gives the results of all analyses made since the last report was published. A summary has already been made relative to the standard of goods analyzed. It may be stated here that no goods were found to contain materials different from those guaranteed, except as indicated in the tables.

Available and insoluble phosphoric acid are not determined in bone tankage, and Thomas Phosphate Powder. The degree of the fineness of these materials is determined and the phosphoric acid divided in the ratio of the fine to the medium material. Fine and medium bone are separated by a sieve of 50 meshes to the inch, tankage by a 25-mesh sieve, and Thomas Phosphate Powder by a 100-mesh sieve. Nitrogen in bone and tankage is also divided in the same ratio. These divisions will be found as footnotes to the table, to avoid making separate tables for the materials mentioned.

It may be added here that it is required that all fertilizers put on the market on or after July 1st of this year carry a guarantee of the percentage of nitrogen in its different forms; that is, of nitrogen in nitrates, in ammonia salts, and in organic matter. Most of the analyses reported in this bulletin are of samples collected from goods that were put on the market before July 1st, and consequently have a guarantee of the total nitrogen only.

Nitrogen in ammonia salts will be often found reported when nitrogen in this form is not guaranteed. In such cases this form of nitrogen is produced by conversion of organic nitrogen, and is not to be considered a deviation from the guarantee of materials used. This form is not reported separately when it is less than 0.20 per cent, unless nitrogen in this form has been guaranteed.

In the report of analyses, the percentage of chlorin is given when it exceeds 0.50 per cent; and when there is an amount present sufficient to combine with half or more of the potash, the potash is rated as derived from potassium chlorid (muriate) to the extent of the combining equivalent of the chlorin, whether it is in actual combination or not. This allowance is really too liberal, and may seem to open the way for the dishonest manufacturer to mix muriate with his sulfate; but it is assumed that the manufacturers are honest, and that when sulfate is claimed, sulfate has been used, and that any chlorin present

is from some other materials used. The microscope will, however, show whether or not fraud was attempted. Goods may be made practically free from chlorin, as will be seen by referring to the table of analyses.

The following abbreviations are used to designate materials used: Nit. = nitrate of soda; Bl. = blood; Bn. = bone; Am. Sul. = ammonium sulfate; Bat. G. = bat guano; Bd. G. = bird guano; Fs. G. = fish guano*; T. = tankage.

*Fish scrap.

ANALYSES AND VALUATIONS.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	Agricultural Chemical Works, Los Angeles, Cal.		
162	Lawn	Patterson & Scott, Pomona	$21.35
	Guaranteed		19.55
163	Orange and Lemon No. 1	Patterson & Scott, Pomona	28.28
	Guaranteed		28.10
164	Special Orange and Lemon for Light Soil	G. A. Herdeg, Riverside	23.08
	Guaranteed		23.10
165	Special Orange and Lemon for Heavy Soil	G. A. Herdeg, Riverside	21.24
	Guaranteed		22.90
166	Special Orange and Lemon	J. B. Davis, National City	23.60
	Guaranteed		25.82
167	Riverside Special Fertilizer	G. A. Herdeg, Riverside	24.36
	Guaranteed		25.70
168	Special Grape	Pioneer Fruit Co., Sacramento	21.96
	Guaranteed		21.33
159	Tankage	Patterson & Scott, Pomona	26.49
	Guaranteed		25.00
	American Agricultural Chemical Co., California Works, Los Angeles, Cal.		
169	Bradley's Lawn	F. E. Dudderar, Covina	28.36
170	do	Pacific Wood and Coal Co., San Diego.	26.26
	Guaranteed		26.48
171	Bradley's Nursery Stock	R. S. Thompson, Highland	27.56
172	do	F. E. Dudderar, Covina	28 08
173	do	Pacific Wood and Coal Co., San Diego.	27.45
	Guaranteed		26.48
174	Bradley's Orange and Lemon	Graham-Cope Com'l Co., Redlands	28 38
175	do	F. E. Dudderar, Covina	27.88
176	do	Pacific Wood and Coal Co., San Diego.	26 79
	Guaranteed		25.56
	The Armour Fertilizer Works, Los Angeles, Cal.		
177	Armour's Dried Blood	W. T. Henderson, Riverside	49.32
178	do	H. P. Greene, San Diego	46.37
	Guaranteed		46.80
179	Armour's Bone Meal	H. P. Greene, San Diego	29.89
	Guaranteed		26.95
155	Armour's Bone Blood and Potash	G. A. Hanson, Upland	32 89
180	do	H. P. Greene, San Diego	34.30
181	do	J. C. Boyd, Rialto	34.15
182	do	J. S. Edwards, Redlands	33.47
	Guaranteed		32.40

ANALYSES AND VALUATIONS.

Laboratory Number	Pounds per Hundred.												
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin.
	Available.	Insoluble.	Total.	In Nitrates.	In Ammonia Salts.	Organic.	Total.	Guaranteed as Derived From.	Muriate.	Sulfate.	Total.	
162	5.28	4.45	9.73	0.41	0.28	2.37	3.06					
	5.00	**5.00**	**10.00**	----	-----	------	**2.50**	Nit., Bl., Bn., T., Bat. G.	**2.20**	---	----	2.32
									2.50	-----	-----	-----
163	5.59	5.23	10.82	0.96	------	3.09	4.05					
	5.00	**5.00**	**10.00**	------	----	-----	**4.00**	Nit., Bl., Bn., T.	3.40	1.46	4.86	2.62
									---	**5.00**	-----	-----
164	5.41	3.15	8.56	0.62	0.24	2.15	3.01					
	6.00	**2.00**	**8.00**	----	------	-----	**3.00**	Nit., Bl., Bn., T.	-----	3.92	------	1.28
									----	**4.00**	------	-----
165	4.27	5.13	9.40	0.69	------	2.27	2.96					
	6.00	**4.00**	**10.00**	**1.00**	------	**2.00**	**3.00**	Nit., Bl., Bn., T.	----	2.88	-----	------
									-----	**3.00**	------	------
166	4.65	4.59	9.24	0.51	-----	2.57	3.08					
	5.00	**5.00**	**10.00**	----	------	-----	**3.29**	Nit., Bl., Bn., Bat. G.	3.35	1.49	4.84	2.58
									------	**5.00**	----	------
167	5.26	4.72	9.98	0.96	------	2.59	3.55					
	5.00	**5.00**	**10.00**	**1.00**	-----	**3.00**	**4.00**	Nit, Bl., Bn., T.	------	3.03	------	------
									------	**3.00**	------	------
168	6.30	3.66	9.96	0.34	------	1.45	1.79					
	6.00	**2.00**	**8.00**	----	----	------	**1.75**	Nit, Bl., Bn., T.	------	5.37	----	------
									-----	**6.00**	------	------
159	6.23	6.61	12.84	See foot note.		4.78	----	----------	------	------	------	------
	7.00	**5.00**	**12.00**	------	------	**5.00**	----	----------	------	------	------	------
									------	------	------	------
169	8.74	1.48	10.22	3.16	0.25	0.60	4.01					
170	9.10	1.34	10.44	2.72	------	1.17	3.89		----	3.61	------	------
	9.00	**1.00**	**10.00**	----	------	------	**4.10**		------	1.78	-----	------
								Nit., Bl., Bn., T., Bat. G., Fs. G.	-----	**1.50**	----	------
171	9.26	1.80	11.06	2.66	0.34	1.04	4.04					
172	9.69	1.07	10.76	2.65	0.49	1.02	4.16		------	2.03	------	------
173	9.79	1.29	11.08	2.49	------	1.51	4.00		------	1.97	------	0.80
	9.00	**1.00**	**10.00**	----	------	------	**4.10**		------	1.70	------	------
								Nit., Bl., Bn., T., Bat. G., Fs. G.	------	**1.50**	------	------
174	9.33	1.40	10.73	2.31	0.59	0.92	3.82					
175	9.49	1.06	10.55	2.73	0.49	1.00	4.22		------	3.32	------	------
176	8.88	1.16	10.04	2.03	0.42	1.22	3.67		------	1.87	------	------
	8.00	**1.00**	**9.00**	------	----	------	**3.70**		------	2.90	-----	0.62
								Nit., Bl., Bn., T., Bat. G., Fs. G.	------	**3.00**	------	------
177	----	------	----	------	------	13.70	------					
178	------	------	------	------	------	12.88	------		------	------	------	------
	----	----	------	------	-----	**13.00**	-----		------	------	------	------
179	See foot note.		21.52	See foot note.		3.67	----		-----	------	------	------
	-----	----	**24.00**	----	------	**2.50**	----		------	------	------	-----
155	8.31	1.02	9.33	------	------	4.18	4.18		------	6.48	------	0.66
180	9.00	1.08	10.08	0.59	0.20	3.81	4.60		------	5.89	------	0.76
181	7.67	2.64	10.31	0.72	0.26	3.13	4.11		------	7.91	-----	0.86
182	8.07	1.65	9.72	1.50	------	2.49	3.99		------	7.99	------	0.74
	8.00	**2.00**	**10.00**	----	----	----	**4.00**	Nit., Bl., Bn., T.	------	**7.00**	------	------

159— Nitrogen in fine Tankage, 3.86%; in medium Tankage, 0.92%.

179 { Phosphoric Acid in fine Bone, 15.06%; in medium Bone, 6.46%.
{ Nitrogen in fine Bone, 2.57%; in medium Bone, 1.10%.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	The Armour Fertilizer Works, Los Angeles, Cal.		
156	Armour's Fruit Special	G. A. Hanson, Upland	$20.37
183	do	J. S. Edwards, Redlands	23.57
184	do	H. P. Greene, San Diego	22.29
	Guaranteed		21.85
185	Armour's Fruit and Vine	H. P. Greene, San Diego	27.35
	Guaranteed		27.20
186	Armour's Lawn and Garden Fertilizer	W. T. Henderson, Riverside	23.94
	Guaranteed		23.50
187	Armour's Lawn and Garden Fertilizer	H. P. Greene, San Diego	21.68
	Guaranteed		23.50
188	Nitrate of Soda	H. P. Greene, San Diego	49.60
	Guaranteed		46.50
189	Armour's Orange Tree Manure	J. C. Boyd, Rialto	28.17
190	do	J. S. Edwards, Redlands	28.10
191	do	H. P. Greene, San Diego	28.80
	Guaranteed		25.30
192	Special Fertilizer	J. S. Edwards, Redlands	26.24
	Guaranteed		26.20
153	Special Fertilizer	A. Moncue, Palermo	26.14
	Guaranteed		26.00
	Balfour, Guthrie & Co., San Francisco, Cal.		
194	Thomas Phosphate Powder	John Niven, San Diego	18.34
	Guaranteed		18.47
195	Thomas Phosphate Powder	Balfour, Guthrie & Co's W'house, S. F.	17.29
	Guaranteed		17.34
	California Fertilizer Works, San Francisco, Cal.		
196	Fruit and Vine	Albert Bots, Palermo	32.02
	Guaranteed		28.46
197	Fruit, Orange and Vine	Albert Bots, Palermo	29.32
	Guaranteed		27.35
198	Nitrate of Soda	Cal. Fertilizer Works, W'house, S. F.	45.79
	Guaranteed		46.50
199	Nursery Stock	Albert Bots, Palermo	32.43
	Guaranteed		26.57
200	Sulfate of Potash	Albert Bots, Palermo	57.65
201	do	Cal. Fertilizer Works, W'house, S. F.	58.46
	Guaranteed		57.60
202	Thomas Phosphate Powder	Cal. Fertilizer Works, W'house, S. F.	17.75
	Guaranteed		17.10
154	Special Fertilizer	A. Moncue, Palermo	27.94
	Guaranteed		26.40

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin
	Available	Insoluble.	Total	In Nitrates.	In Ammonia Salts	Organic	Total	Guaranteed as Derived From.	Muriate	Sulfate	Total	
156	7.64	1.21	8.85			1.46	1.46			4.57		
183	9.36	1.86	11.22	0.87	0.24	0.69	1.80		4.94	0.41	5.35	3.80
184	7.86	1.56	9.42	0.06	0.33	1.29	1.68			5.15		0.56
	8.00	2.00	10.00				1.50	Nit., Bl., Bn., T.		5.00		
185	6.66	0.34	7.00	0.87		1.58	2.45			9.13		0.86
	6.00	2.00	8.00				2.00	Nit., Bl., Bn., T.		10.00		
186	4.11	0.59	4.70	0.11		4.01	4.12			3.61		0.54
	4.00	1.00	5.00				4.00	Nit., Bl., Bn., T.		4.00		
187	4.62	0.92	5.54	0.83		2.59	3.42			3.36		0.52
	4.00	1.00	5.00	1.50		2.50	4.00	Nit., Bl., Bn., T.		4.00		
188				16.00				Guano.				
				15.00								
189	8.35	1.63	9.98	1.84		1.78	3.62			4.50		0.82
190	10.03	1.17	11.20	1.14	0.29	1.80	3.23			3.84		
191	8.26	2.83	11.09	1.44		2.28	3.72			4.19		0.56
	8.00	2.00	10.00				3.00	Nit., Bl., Bn., T.		4.00		
192	9.55	0.63	10.18	1.89		1.76	3.65			2.03		0.54
	8.00	2.00	10.00				4.00	Nit., Bl., Bn., T.		2.00		
153	9.99	1.63	11.62			3.97	3.97					
	10.00	1.00	11.00				4.00	Nit., Bl., Bn., T.				
194	See foot note.		19.18									
			19.45									
195	See foot note.		18.22									
			18.26									
196	7.17	2.53	9.70	1.35	0.58	1.06	2.99			10.13		1.06
	6.00	2.00	8.00				2.50	Nit., Animal matter.		10.00		
197	8.03	3.94	11.97	1.19	0.24	1.32	2.75			7.12		2.30
	8.00	2.00	10.00				2.50	Nit., Animal matter.		7.00		
198				14.77								
				15.00								
199	8.36	2.88	11.24	2.42	0.66	1.08	4.16			6.08		0.92
	8.00	2.00	10.00				4.15	Nit., Animal matter.		2.00		
200										48.04		18.52
201										48.72		1.36
										48.00		
202	See foot note.		18.52									
			18.00									
154	10.23	2.87	13.10		0.32	3.93	4.25					
	10.00	2.00	12.00				4.00	Animal matter				

194—Phosphoric Acid in fine Powder, 14.69%; in medium Powder, 4.49%.
195—Phosphoric Acid in fine Powder, 13.63%; in medium Powder, 4.59%.
202—Phosphoric Acid in fine Powder, 14.29%; in medium Powder, 4.23%.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	Chas. S. Hardy, San Diego, Cal.		
203	Hardy's Tankage	Chas. S. Hardy, San Diego	$30.25
	Guaranteed		23.55
	Maier Fertilizer Co., Los Angeles, Cal.		
204	"A A"	Manufacturers	31.03
	Guaranteed		29.50
205	"T"	Manufacturers	27.23
	Guaranteed		21.90
	Mapes Formula and Peruvian Guano Co., New York.		
206	Mapes Orange Tree Manure	J. J. Prendergast, Redlands	27.43
	Guaranteed		22.37
	Mohr & Yoerk Packing Co., Sacramento, Cal.		
207	M. and Y.	Manufacturers	30.81
	Guaranteed		32.17
	S. M. Neely, San Diego, Cal.		
157	Bird Guano	Call Fruit Co., Corona	49.66
208	do	S. M. Neely, San Diego	46.10
	Guaranteed		33.96
	N. Ohlandt & Co., San Francisco, Cal.		
209	Ohlandt's Lawn Dressing	Manufacturers	29.39
	Guaranteed		28.50
	Southern California Fertilizer Co., Ontario, Cal.		
210	Fruit and Vine	Manufacturers	32.06
	Guaranteed		28.20
211	Lawn and Nursery	Manufacturers	31.99
	Guaranteed		28.00
212	Orange	Manufacturers	30.64
213	do	H. P. D. Kingsbury, Redlands	28.66
	Guaranteed		24.77
214	Orange Special	H. P. D. Kingsbury, Redlands	33.35
215	do	Manufacturers	32.28
	Guaranteed		29.96
	Swift & Co., Chicago.		
216	Swift's Ground Dried Blood	M. S. Ratliff, Colton	47.77
	Guaranteed		47.52
217	Swift's Special Bone Meal	M. S. Ratliff, Colton	29.76
	Guaranteed		26.14

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.												
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin.
	Available.	Insoluble.	Total.	In Nitrates.	In Ammonia Salts	Organic.	Total	Guaranteed as Derived From.	Muriate.	Sulfate.	Total.	
203	See foot note.		18.35			4.13						
			12.00			4.50						
204	6.95	4.24	11.19	See foot note.		6.36						
	7.00	5.00	12.00			6.00		Bl., Bn., T.				0.64
205	9.02	7.78	16.80	See foot note.		3.85						
	8.00	6.00	14.00			3.00		Bl., Bn., T.				
206	8.41	2.72	11.13	2.32	0.25	0.73	3.30			4.44		0.90
	6.00	2.00	8.00				3.29	Nit., Animal matter.		3.30		
207	See foot note.		25.98	See foot note.		3.31					0.14	
			26.61			3.10		Slaughter house refuse.			1.06	
157	10.79	0.82	11.61	1.07	2.57	7.78	11.42		2.03			2.56
208	8.81	0.76	9.57	0.43	2.25	8.46	11.14		2.03			2.70
	8.86	1.10	9.96	0.63	1.67	4.67	6.97		1.74			
209	8.47	0.15	8.62	3.84						6.04		
	8.00	1.00	9.00	4.00				Nit.		5.00		
210	10.41	1.79	12.20	0.94		2.35	3.29			6.27		0.54
	8.00	1.00	9.00				2.88	Nit., Bl., Bn., T.		7.00		
211	8.34	1.84	10.18	2.18		3.28	5.46			2.35		0.82
	8.00	1.00	9.00				5.00	Nit., Bl., Bn., T.		1.00		
212	9.71	1.48	11.19	1.45		2.76	4.21			3.32		0.60
213	8.50	1.35	9.85	1.48		2.67	4.15			3.20		0.54
	9.00	1.00	10.00				3.30	Nit., Bl., Bn., T.		2.00		
214	9.95	1.66	11.61	1.87		3.09	4.96			3.30		0.68
215	9.67	1.33	11.00	1.93		2.71	4.64			3.78		0.60
	10.00	1.00	11.00				4.12	Nit., Bl., Bn., T.		3.00		
216						13.27						
						13.20						
217	See foot note.		30.12	See foot note.		1.69						
			29.50			0.82						

203 } Phosphoric Acid in fine Tankage, 17.43%; in medium Tankage, 0.92%.
} Nitrogen in fine Tankage, 3.92%; in medium Tankage, 0.21%.

204—Nitrogen in fine Material, 4.61%; in medium Material, 1.75%.

205—Nitrogen in fine Material, 2.89%; in medium Material, 0.96%.

204 and 205 not being acidulated, are rated as Tankage.

207 } Phosphoric Acid in fine Material, 11.56%; in medium Material, 14.42%.
} Nitrogen in fine Material, 1.47%; in medium Material, 1.84%.

217 } Phosphoric Acid in fine Bone, 16.87%; in medium Bone, 13.25%.
} Nitrogen in fine Bone, 0.95%; in medium Bone, 0.74%.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	Swift & Co., Chicago.		
218	Swift's Special Acidulated Bone	M. S. Ratliff, Colton	$26.44
	Guaranteed		25.47
219	Swift's Diamond "A"	M. S. Ratliff, Colton	30.41
	Guaranteed		30.52
220	Swift's Diamond "E"	C. B. Smith, Redlands	33.09
221	do	M. S. Ratliff, Colton	31.97
	Guaranteed		30.51
222	Swift's Diamond "G"	M. S. Ratliff, Colton	32.94
	Guaranteed		31.28
	Union Fertilizer Co., Los Angeles, Cal.		
223	Bone Meal	J. W. Freeman, Upland	27.69
224	do	W. T. Bill, Redlands	28.46
	Guaranteed		26.90
225	Fruiting Fertilizer	J. W. Freeman, Upland	25.96
	Guaranteed		23.87
226	Fruiting Fertilizer	W. T. Bill, Redlands	33.62
	Guaranteed		32.60
227	Special Fruiting Fertilizer	J. W. Freeman, Upland	27.33
	Guaranteed		29.08
229	Nursery Fertilizer	J. W. Freeman, Upland	30.37
230	do	W. T. Bill, Redlands	21.20
	Guaranteed		30.24
231	Orange and Lemon Fertilizer	J. W. Freeman, Upland	25.64
232	do	W. T. Bill, Redlands	25.48
	Guaranteed		25.00
	West Coast Fertilizer Works, Los Angeles, Cal.		
139	Special	J. E. Davis, Redlands	23.78
233	do	W'house Wilcox-Rose Mercantile Co., Colton	24.36
	Guaranteed		24.85
	Western Meat Co., San Francisco.		
234	W. M. Co. Tankage	Manfacturers	35.96
	Guaranteed		36.25

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.												
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin.
	Available.	Insoluble.	Total.	In Nitrates.	In Ammonia Salts	Organic.	Total.	Guaranteed as Derived From.	Muriate.	Sulfate.	Total.	
218	16.59	3.60	20.19	----	----	1.35	----	----	----	----	----	----
	18.00	2.00	20.00	----	----	0.82	----	----	----	----	----	----
219	14.81	3.36	18.17	----	----	3.13	----	This brand acidulated.	----	----	----	----
	15.00	2.00	17.00	----	----	3.29	----	Bl., Bn., T.	----	----	----	----
220	See foot	note.	18.10	See foot	note.	5.30	----	----	----	----	----	1.00
221	See foot	note.	17.86	See foot	note.	4.95	----	----	----	----	----	0.90
	----	----	19.00	----	----	4.94	----	Bl., Bn., T.	----	----	----	----
222	See foot	note.	18.84	See foot	note.	3.22	----	----	----	4.67	----	0.66
	----	----	19.00	----	----	3.25	----	Bl., Bn., T.	----	5.00	----	----
223	See foot	note.	21.10	See foot	note.	3.91	----	----	----	----	----	----
224	See foot	note.	21.82	See foot	note.	4.10	----	----	----	----	----	----
	----	----	22.00	----	----	3.00	----	----	----	----	----	----
225	9.55	2.53	12.08	0.46	0.90	1.40	2.76	----	----	3.05	----	0.76
	7.00	2.00	9.0C	0.75	0.60	1.65	3.00	Nit., Guano, Bn., T.	----	3.50	----	----
226	9.70	1.48	11.18	0.98	0.89	2.71	4.58	----	----	4.59	----	0.74
	10.00	2.00	12.00	----	----	----	4.00	Guano	----	5.00	----	----
227	8.21	1.28	9.49	0.81	0.74	2.05	3.60	----	----	3.74	----	----
	8.00	2.00	10.00	1.00	0.75	2.25	4.00	Nit., Guano, Bn., T.	----	4.00	----	----
229	6.80	1.56	8.36	0.56	0.90	4.11	5.47	----	----	1.72	----	0.94
230	4.94	1.16	6.10	0.84	0.58	2.44	3.86	----	----	1.22	----	0.64
	7.00	2.00	9.00	----	----	----	5.60	Nit., Guano, T.	----	1.50	----	----
231	8.33	2.11	10.44	0.45	0.55	1.96	2.96	----	----	3.63	----	0.60
232	8.12	2.02	10.14	0.30	0.69	1.96	2.95	----	----	3.71	----	----
	8.00	2.00	10.00	----	----	----	3.00	Guano, T.	----	3.50	----	----
139	12.70	1.59	14.29	----	----	2.14	----	----	----	0.21	----	----
233	13.51	1.80	15.31	0.12	----	1.88	2.00	----	----	0.21	----	----
	12.00	1.00	13.00	----	----	----	2.50	Nit., Bl., Bn., T.	----	1.00	----	----
234	See foot	note.	8.85	See foot	note.	8.75	----	----	----	----	----	----
	----	----	8.50	----	----	9.50	----	----	----	----	----	----

220, 221, and 222 not being acidulated, are rated as Tankage.

220 { Phosphoric Acid in fine Material, 14.84%; in medium Material, 3.26%.
Nitrogen in fine Material, 4.35%; in medium Material, 0.95%.

221 { Phosphoric Acid in fine Material, 14.82%; in medium Material, 3.04%.
Nitrogen in fine Material, 4.11%; in medium Material, 0.84%.

222 { Phosphoric Acid in fine Material, 16 96%; in medium Material, 1.88%.
Nitrogen in fine Material, 2 90%; in medium Material, 0.32%.

223 { Phosphoric Acid in fine Bone, 6.33%; in medium Bone, 14.77%.
Nitrogen in fine Bone, 1.17%; in medium Bone, 2.74%.

224 { Phosphoric Acid in fine Bone, 5.46%; in medium Bone, 16.36%.
Nitrogen in fine Bone, 1.03%; in medium Bone, 3.07%.

234 { Phosphoric Acid in fine Tankage, 6.64%; in medium Tankage, 2.21%.
Nitrogen in fine Tankage, 6.56%; in medium Tankage, 2.19%.

Two samples of gypsum, registered by the Agricultural Chemical Works, Los Angeles, Cal., were analyzed. The results are given below.

Sample No. 160, collected from Patterson & Scott, Pomona.

	Hydrated Calcium Sulfate.
Found	61.14 %
Guaranteed	61.00 %

Sample No. 161, collected from Pioneer Fruit Co., Sacramento.

	Hydrated Calcium Sulfate.
Found	63.28 %
Guaranteed	61.00 %

REPORTS OF SALES.

The sworn statements of manufacturers and dealers, required by Section 8 of the law, showed sales of fertilizers of all kinds for the year ending June 30, 1904, amounting to 9,790 tons.

REPORTS AND BULLETINS AVAILABLE FOR DISTRIBUTION.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1898. Partial Report of Work of Agricultural Experiment Station for the years 1895-96 and 1896-97.
1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-1903.

BULLETINS.

Reprint. Endurance of Drought in Soils of the Arid Region.
No. 125. Australian Saltbush.
128. Nature, Value, and Utilization of Alkali Lands.
129. Report of the Condition of Olive Culture in California.
131. The Phylloxera of the Vine.
132. Feeding of Farm Animals.
133. Tolerance of Alkali by Various Cultures.
135. The Potato-Worm in California.
137. Pickling Ripe and Green Olives.
138. Citrus Fruit Culture.
139. Orange and Lemon Rot.
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143. California Peach-Tree Borer.
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158. California Olive Oil; its Manufacture.
159. Contribution to the Study of Fermentation.
160. The Hop Aphis.
161. Tuberculosis in Fowls.

CIRCULARS.

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COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

BULLETIN No. 162.

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1905.

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G. W. SHAW, M.A., Ph.D., *Assistant Chemist.* (*Starches, Oils, Beet-Sugar.*)
GEORGE E. COLBY, M.S., *Assistant Chemist.* (*Fruits, Waters, Insecticides.*)
RALPH E. SMITH, B.S., *Plant Pathologist.*
A. R. WARD, B.S.A., D.V.M., *Veterinarian, Bacteriologist.*
E. H. TWIGHT, B.Sc., Diplomé E.A.M., *Viticulturist.*
E. W. MAJOR, B.Agr., *Animal Industry.*
A. V. STUBENRAUCH, M.S., *Assistant Horticulturist, in charge of Substations.*
WARREN T. CLARKE, B.S., *Assistant Field Entomologist.*
H. M. HALL, M.S., *Assistant Botanist.*
H. J. QUAYLE, A.B., *Assistant Entomologist.*
GEORGE ROBERTS, M.S., *Assistant Chemist, in charge Fertilizer Control.*
C. M. HARING, D.V.M., *Assistant Veterinarian and Bacteriologist.*
C. A. TRIEBEL, Ph.G., *Assistant in Agricultural Laboratory.*
C. A. COLMORE, B.S., *Clerk to the Director.*

R. E. MANSELL, *Foreman of Central Station Grounds.*
JOHN TUOHY, *Patron,*
JULIUS FORRER, *Foreman,* } Tulare Substation, Tulare.
J. E. McCOMAS, *Patron,* Pomona,
J. W. MILLS, *Superintendent,* Pomona,
In charge Cooperation Experiments of Southern California,
JOHN H. BARBER, *Assistant Superintendent,* Ontario, } Southern California Substation.
J. W. ROPER, *Patron,*
HENRY WIGHTMAN, *In charge,* } University Forestry Station, Chico.
ROY JONES, *Patron,*
WM. SHUTT, *Foreman,* } University Forestry Station, Santa Monica.
H. O. WOODWORTH, M.S., *Foreman of Poultry Station,* Petaluma.

The Station publications (REPORTS AND BULLETINS), *so long as available, will be sent to any citizen of the State on application.*

COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

Registrations.—Below is given a list of manufacturers of, and dealers in, commercial fertilizers who have obtained certificates of registration under the provisions of the California fertilizer law for the year beginning July 1, 1904. A list is also given of the brands of fertilizers and fertilizing materials offered for sale by the registered dealers.

The star (*) preceding a brand signifies that the fertilizer inspector was unable to find a sample on the market or in the manufacturer's warehouse when the inspection herein reported was made.

Agricultural Chemical Works, Los Angeles, Cal.

Registration No. 8.

*Apricot.
*Bat Guano.
*Berry.
*Blood Meal.
*Fine Ground Bone.
*Grape.
Gypsum.
Lawn.
*Peach.
*Muriate of Potash.
*Nitrate of Soda.
No. 1 Lemon.
No. 1 Orange and Lemon.
*Nursery.
*Olive.
*Potato.
*Prune.
*Rose.
Special Orange and Lemon for Heavy Soil.
Special Orange and Lemon for Light Soil.
*Special Orange and Lemon for Non-fruiting Trees.
*Sulfate of Potash.
*Superphosphate.
*Double Superphosphate.
Tankage.
*Vegetable.
*Walnut and Almond.

American Agricultural Chemical Co., California Works, Los Angeles, Cal.

Registration No. 1.

*Acid Phosphate.
*Bradley's Fruit and Vine.
*Bradley's Special Fruit and Vine.
Bradley's Lawn.
*Nitrate of Soda.
Bradley's Nursery Stock.
Bradley's Orange and Lemon.
*Sulfate of Potash.
*Bradley's Vegetable.

The Armour Fertilizer Works, Los Angeles, Cal.

Registration No. 7.

*Armour's Acidulated Bone Meal.
Armour's Bone Meal.
Armour's Bone, Blood and Potash.
*Concentrated Superphosphate.
Armour's Dried Blood.
Armour's Fruit Special.
Armour's Fruit and Vine.
Armour's Lawn and Garden Fertilizer.
Nitrate of Soda.
Armour's Orange Tree Manure.
*Armour's Special 582.
*Sulfate of Potash.
*Armour's Tankage.

Balfour, Guthrie & Co., San Francisco, Cal.

Registration No. 10.

*Muriate of Potash.
*Nitrate of Soda.
*Sulfate of Potash.
Thomas Phosphate Powder.

California Fertilizer Works, Inc., San Francisco, Cal.

Registration No. 3.

*Blood.
*Double Manure Salt.
*Fish.
Fruit and Vine.
*Special Fruit and Vine.
Fruit, Orange and Vine.
*High Grade Ammoniated Bone Superphosphate.
*High Grade Bone Meal.
*Hops.
*Lemon Tree (M).
*Muriate of Potash.
Nitrate of Soda.
Nursery.
*Odorless Lawn Dressing.
*Orange and Lemon.
*Orange Tree.
*Orange Tree B.
*Special Orange Tree.
*Peach.
*Special Fertilizer with Iron Sulfate
*Sulfate of Ammonia.
Sulfate of Potash.
*Tankage.
Thomas Phosphate Powder.
*Truck and Berry.
*Special Fertilizer No. 1.
*Special Fertilizer No. 2.
*Special Fertilizer No. 3.
*Special Fertilizer No. 4.
*Special Fertilizer No 5.
*Special Fertilizer No. 6.

Cudahy Packing Co., South Omaha, Neb.

Registration No. 16.

*Cudahy's Blood and Bone.

Chas. S. Hardy, San Diego, Cal.

Registration No. 17.

Hardy's Tankage.

Hawaiian Fertilizer Co., Ltd., San Francisco, Cal.

Registration No. 19.

*Bone Meal.
*Muriate of Potash.
*Nitrate of Soda.
*Sulfate of Potash.
*Thomas Phosphate Powder.

The Maier Fertilizer Co., Los Angeles, Cal.

Registration No. 6.

"AA" (four formulas under same name).
"T" (four formulas under same name).

Mapes Formula and Peruvian Guano Co., New York.

Registration No. 12.

*Mapes Fruit and Vine Manure.
Mapes Orange Tree Manure.

Mohr & Yoerk Packing Co., Sacramento, Cal.

Registration No. 21.

M. and Y.

S. M. Neely, San Diego, Cal.

Registration No. 20.

Bird Guano.

N. Ohlandt & Co., San Francisco, Cal.

Registration No. 4.

*Dissolved Bone Meal.
*Raw Bone Meal.
*Steamed Bone Meal.
*Double Manure Salt.
*Dried Blood.
*Fish Scrap.
*(OO) Grape Fertilizer.
*Kainit.
Oblandt's Lawn Dressing.
*Muriate of Potash.
*Nitrate of Soda.
*(N) Orange and Lemon.
*(NN) Orange and Lemon.
*(O) Peach, Almond and Prune.
*Sulfate of Ammonia.
*Sulfate of Potash.
*Superphosphate.
*Double Superphosphate.
*Tankage No. 1.
*Tankage No. 2.
*Thomas Phosphate Powder.
*(OOO) Vegetable Grower.

Pacific Bone, Coal and Fertilizing Co., San Francisco, Cal.

Registration No. 14.

*Acidulated Bone Meal.
*Ammoniated Dissolved Bone Meal.
*Pure Dissolved Bone Meal.
*Pure Bone Meal.
*"Ceres" Brand.
*"Citrone" Brand.
*Double Superphosphate.
*Muriate of Potash.
*Nitrate of Soda.
*"Pomona" Brand.
*Sulfate of Potash.
*"Supine" Brand.
*Thomas Phosphate Powder.

Southern California Fertilizer Co., Ontario, Cal.

Registration No. 13.

*Animal Tankage.
*Double Superphosphate.
Fruit and Vine.
*Ground Dried Blood.
*Ground Steamed Bone.
Lawn and Nursery.
*Nitrate of Soda.
Orange.
Orange Special.
*Orange and Lemon.
*Root and Tuber Special.
*Sulfate of Potash.

Swift & Co., Chicago, Ill.

Registration No. 5.

Swift's Diamond "A" Fertilizer.
*Swift's Diamond "B" Fertilizer.
*Swift's Diamond "C" Fertilizer.
*Swift's Diamond "D" Fertilizer.
Swift's Diamond "E" Fertilizer.
Swift's Diamond "G" Fertilizer.
Swift's Ground Dried Blood.
Swift's Special Acidulated Bone.
Swift's Special Bone Meal.

Union Fertilizer Co, Los Angeles, Cal.

Registration No. 9.

*Blood.
Bone Meal.
*Double Superphosphate.
Fruiting Fertilizer.
Special Fruiting Fertilizer.
*Lawn Fertilizer.
Nursery Fertilizer.
Orange and Lemon Fertilizer.
*Sulfate of Potash.
*Tankage.

Western Meat Co., San Francisco, Cal.

Registration No. 11.

*W. M. Co. Bone Meal.
W. M. Co. Tankage.

The Woodbridge Chemical Co., San Bernardino, Cal.

Registration No. 15.

*Apricot.
*Bat Guano.
*Blood.
*Bone Meal.
*Citrus A.
*Citrus B.
*Grape.
*Hoof Meal.
*Lemon.
*Muriate of Potash.
*Nitrate of Soda.
*Orange and Lemon No. 1.
*Peach and Prune.
*Rose Fertilizer.
*Sulfate of Potash.
*Tankage.
*Vegetable Fertilizer.
*Vegetable Fertilizer for Leguminous Crops.
*Walnut and Almond.

Summarizing the foregoing list, it will be seen that 19 companies have registered 190 brands, which may be classified as follows:

Complete Fertilizers	87
Bone Meal, Tankage, and Fish	34
Nitrogenous Superphosphates	10
Dried Blood	8
Nitrate of Soda	10
Ammonium Sulfate	2
Potash Salts	21
Superphosphates	9
Thomas Phosphate Powder	5
Bird and Bat Guanos	3
Gypsum	1
Total	190

The West Coast Fertilizer Co., which was registered last year, is out of business this year, but some of its goods are yet on the market, a sample of which was collected and analyzed and is herein reported.

Following the requirements of Section 4 of the fertilizer law, which requires that an inspection be made between July 1st and September 1st, an inspection covering the State was made in August. Seventy-five samples were collected on this inspection, all of which were analyzed and are reported in this bulletin, with one exception, a sample taken from a stock of only two bags, and for this reason not considered a representative sample. In addition to these samples collected by the inspector, six samples have been sent by farmers for analysis since the last bulletin on fertilizers was issued, and these results are also given.

The samples included in this report may be classified as follows:

Complete Fertilizers	50
Bone Meal and Tankage	12
Nitrogenous Superphosphates	4
Nitrate of Soda	2
Sulfate of Potash	2
Bird Guano	2
Gypsum	2
Thomas Phosphate Powder	3
Blood	3
Total	80

These 80 samples represent 54 registered fertilizers, fertilizing materials, and special formulas. These numbers will doubtless impress most readers of this report as being small when it is remembered that 190 brands and materials have been registered; and so they are. Experience has shown that between July 1st and September 1st practically all the goods found on the market are remnants of the preceding spring trade. The law does not prohibit other inspections, and the State will be thoroughly inspected again each year at such a time as circumstances indicate that the largest amount of goods will be found on the market. The plan of inspection is to get as many samples as possible from goods actually on the market. After having secured samples of as many brands as possible in this way, the inspector then visits the factories and endeavors to secure samples of the brands not found in the hands of agents. Notwithstanding this procedure, many brands are registered which are not found on the market or in the factory. The fact is that the trade in fertilizers is limited to a few standard brands. The inference is that many of the brands are advertised to meet the supposed needs of farmers, but are made up only as orders are received.

Two reports will be issued each year. The first will give the results of the inspection made prior to September 1st, and the second the results of the subsequent inspections made during the winter and spring seasons. The reports will be distributed as soon after the analyses are

finished as it is possible to get them through the press. The first may be looked for about December, and the second about May or June.

DEFICIENCIES.

Section 4 of the fertilizer law provides that "Whenever the analysis certified by the said Director shall show a deficiency of not more than one fourth of one per cent of nitrogen, or one per cent of soluble or available phosphoric acid, or one half of one per cent of potash soluble in distilled water, the statement of the manufacturer or importer, as required in section one of this Act, shall not be deemed to be false in the meaning of this Act."

The following summary gives the average guaranteed composition of the samples containing two or more ingredients, the average of the analyses of the same, and the number of deficiencies found:

Average of Guaranteed Composition.

Available Phosphoric Acid	8.08%
Insoluble Phosphoric Acid	2.07%
Total Phosphoric Acid	11.62%
Nitrogen	3.66%
Potash	3.76%

Average Composition of the above Samples as shown by the Analysis.

		Excess above Guarantee.
Available Phosphoric Acid	8.72%	0.64%
Insoluble Phosphoric Acid	2.13%	0.06%
Total Phosphoric Acid	11.98%	0.36%
Nitrogen	3.92%	0.26%
Potash	3.91%	0.15%

Out of 80 samples, 60 are within the limits of deficiency allowed by law in all the ingredients, although some fall somewhat below the guarantee in one or more ingredients. Five fall below the legal allowance in available phosphoric acid, nine in nitrogen, and eight in potash. Several samples have a shortage in one or more ingredients and have a compensating excess in the other ingredient or ingredients, so that the value calculated from the analysis is equal to or greater than the value calculated upon the guarantee.

The average value for all the samples calculated upon the guarantee is $28.68, while the average value calculated upon the analysis is $30.21.

In estimated value, only one sample is deficient in an amount greater than the value of the deficiencies allowed by law.

ANALYSES FOR CONSUMERS.

Any user of fertilizers may, by paying the fee specified in Section 4 of the fertilizer law, have a sample of his material analyzed. This fee

does not begin to pay the cost of the analysis, but the nominal charge is made to prevent the sending of samples through idle curiosity, as is always the case when analyses are made free of charge.

The sample should be drawn from the amount of fertilizer, and in the manner prescribed by Section 5 of the law, and whenever possible it should be drawn in the presence of the agent, who should sign, as a witness, the certificate given below. If the sample is not drawn in the presence of the agent, it should be done in the presence of some other person, who should sign the certificate as a witness. Special care should be exercised to thoroughly mix the large sample before drawing the small sample to send to the Station. This is absolutely necessary to obtain a trustworthy result. A sample filling a quart fruit jar is about the proper amount to send. Consumers' samples will be given preference and the results reported as soon as possible. The sample should be sent in time to receive the report before the fertilizer is used, or else the bags from which the sample is taken should be reserved until the report is received, so that in case of controversy with the manufacturer an official sample may be drawn.

The form of certificate given below should be used in sending a sample for analysis. Blank forms will be furnished upon application. When more than one sample is sent, they should be marked in some way so that they may be identified. The sample should be sent prepaid, addressed to the Fertilizer Control, Experiment Station, Berkeley, and should bear the name and address of the sender. Bank checks and money orders should be made payable to "The Regents of the University of California." Letters, certificates, and remittances should not be enclosed with the samples, but mailed separately. When the report is received, a tag or label taken from one of the bags sampled should at once be sent and the name and address of the agent from whom the goods were purchased should be given. Analyses will be made only for those who purchase fertilizers for their own use.

CERTIFICATE FOR CONSUMER'S ANALYSIS.

E. W. HILGARD, *Director*,
Berkeley, Calif.

This is to certify that I am not a dealer in, or agent for the sale of any fertilizer, and that the fertilizer, a sample of which I have sent you for analysis, was purchased by me ....., 190.. , for my own use and not for sale.

I further certify that the amount purchased was ..... tons, and that the sample was drawn from ..... packages and was thoroughly mixed.

Upon receipt of the analysis from you, I agree to furnish you with a tag or label taken from one of the packages sampled, and the name and

address of the firm or agent of whom the fertilizer was purchased. I enclose two dollars analysis fee.

(Signature:)----------

(P. O. Address:)----------

(Signature of Witness:)

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An explanation of terms used in reporting fertilizer analyses was given in Bulletin No. 157, and will not be repeated here. The text of the law was also given in the same bulletin. Those who have not obtained a copy of the bulletin may do so by addressing the Director of the Experiment Station, Berkeley, Calif.

VALUATION OF FERTILIZERS.

The "agricultural value" and the "commercial value" of fertilizing materials are not synonymous terms. The agricultural value of a fertilizer is determined by the increase and quality produced by it in the crop. The commercial value of a fertilizer is determined by the cost of the materials which enter into its composition. A fertilizing material may have a low agricultural value on a particular soil and have a high commercial value. On another soil the same material may have a high agricultural value.

Nitrate of soda, at present one of the cheapest forms of nitrogen, produces on some crops the more profitable increase, while on other crops the slower-acting and more expensive forms produce the more profitable increase.

The law of supply and demand regulates the commercial value of fertilizing materials, the *general* agricultural value of the materials regulating largely, of course, the general demand for them.

In calculating the values given in this report, the Experiment Station does not undertake to say what the retail prices of fertilizers should be in this State. The values given are for the unmixed raw materials which enter into the fertilizer, and do not take into account the cost of grinding, mixing, bagging, insurance, drayage, agents' commissions, and other expenses of the manufacturer.

The schedule of values used is given below. They represent as nearly as could be determined the prices at which fertilizing ingredients in raw

materials of good quality could be bought at retail for cash at the warehouse in our largest markets like San Francisco. Quotations were called for from dealers, but they varied so widely that it was very difficult to arrive at a schedule of values that represent the actual market conditions. Two values are given for each sample analyzed, one calculated on the guarantee, and the other on the actual analysis. Even if the trade values are not absolutely correct, they serve as a basis for comparison between the guarantee and the analysis.

SCHEDULE OF TRADE VALUES.

	Cents per Pound.
Phosphoric Acid.	
Available (soluble and reverted)	6
Insoluble in mixed fertilizers	2½
In fine* bone and tankage	4½
In medium* bone and tankage	3½
In fine* Thomas Phosphate Powder	5¼†
In medium* Thomas Phosphate Powder	3¼†
Nitrogen.	
In ammonia salts	18
In nitrates	15½
Organic in—	
Blood	18
Fish, meat, and mixed fertilizers	17½
Fine* bone and tankage	17
Medium* bone and tankage	14
Potash.	
From sulfate	6
From muriate	5

To illustrate the method of calculating the value of a fertilizer, the following example is given:

	Guaranteed Analysis.	Value per lb.	
Available Phosphoric Acid	8.00 % @	6 cents =	$0.48
Insoluble Phosphoric Acid	2.00 % @	2½ cents =	0.05
Total Phosphoric Acid	10.00		
Nitrogen in Nitrates	1.50 % @	15½ cents =	0.23¼
Nitrogen in Organic Matter	2.50 % @	17½ cents =	0.43¾
Total Nitrogen	4.00		
Potash from Sulfate	4.00 % @	6 cents =	0.24
Value			$1.44 per 100 lbs.

$1.44 × 20 = $28.80 per ton.

It is to be hoped that farmers will carefully examine the analyses instead of looking only at the column of commercial values. The agricultural value of a fertilizer depends upon the amount and proportions

*Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas Phosphate Powder by a 100-mesh sieve.

† This method of giving a valuation to Thomas Phosphate Powder is temporary, awaiting the adoption of methods by the Association of Official Agricultural Chemists.

of the essential ingredients contained in forms available to plants, and the materials from which they are derived. The value calculated upon the analysis may be greater than the value calculated upon the guarantee, and at the same time one ingredient be much below guarantee, while another is correspondingly above guarantee. It is desirable that the fertilizer be as evenly mixed as possible.

REPORT OF ANALYSES.

The following table gives the results of all analyses made since the last report was published. A summary has already been made relative to the standard of goods analyzed. It may be stated here that no goods were found to contain materials different from those guaranteed, except as indicated in the tables.

Available and insoluble phosphoric acid are not determined in bone tankage, and Thomas Phosphate Powder. The degree of the fineness of these materials is determined and the phosphoric acid divided in the ratio of the fine to the medium material. Fine and medium bone are separated by a sieve of 50 meshes to the inch, tankage by a 25-mesh sieve, and Thomas Phosphate Powder by a 100-mesh sieve. Nitrogen in bone and tankage is also divided in the same ratio. These divisions will be found as footnotes to the table, to avoid making separate tables for the materials mentioned.

It may be added here that it is required that all fertilizers put on the market on or after July 1st of this year carry a guarantee of the percentage of nitrogen in its different forms; that is, of nitrogen in nitrates, in ammonia salts, and in organic matter. Most of the analyses reported in this bulletin are of samples collected from goods that were put on the market before July 1st, and consequently have a guarantee of the total nitrogen only.

Nitrogen in ammonia salts will be often found reported when nitrogen in this form is not guaranteed. In such cases this form of nitrogen is produced by conversion of organic nitrogen, and is not to be considered a deviation from the guarantee of materials used. This form is not reported separately when it is less than 0.20 per cent, unless nitrogen in this form has been guaranteed.

In the report of analyses, the percentage of chlorin is given when it exceeds 0.50 per cent; and when there is an amount present sufficient to combine with half or more of the potash, the potash is rated as derived from potassium chlorid (muriate) to the extent of the combining equivalent of the chlorin, whether it is in actual combination or not. This allowance is really too liberal, and may seem to open the way for the dishonest manufacturer to mix muriate with his sulfate; but it is assumed that the manufacturers are honest, and that when sulfate is claimed, sulfate has been used, and that any chlorin present

is from some other materials used. The microscope will, however, show whether or not fraud was attempted. Goods may be made practically free from chlorin, as will be seen by referring to the table of analyses.

The following abbreviations are used to designate materials used: Nit. = nitrate of soda; Bl. = blood; Bn. = bone; Am. Sul. = ammonium sulfate; Bat. G. = bat guano; Bd. G. = bird guano; Fs. G. = fish guano*; T. = tankage.

* Fish scrap.

ANALYSES AND VALUATIONS.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	Agricultural Chemical Works, Los Angeles, Cal.		
162	Lawn	Patterson & Scott, Pomona	$21.35
	Guaranteed		19.55
163	Orange and Lemon No. 1	Patterson & Scott, Pomona	28.28
	Guaranteed		28.10
164	Special Orange and Lemon for Light Soil	G. A. Herdeg, Riverside	23.08
	Guaranteed		23.10
165	Special Orange and Lemon for Heavy Soil	G. A. Herdeg, Riverside	21.24
	Guaranteed		22.90
166	Special Orange and Lemon	J. B. Davis, National City	23.60
	Guaranteed		25.82
167	Riverside Special Fertilizer	G. A. Herdeg, Riverside	24.36
	Guaranteed		25.70
168	Special Grape	Pioneer Fruit Co., Sacramento	21.96
	Guaranteed		21.33
159	Tankage	Patterson & Scott, Pomona	26.49
	Guaranteed		25.00
	American Agricultural Chemical Co., California Works, Los Angeles, Cal.		
169	Bradley's Lawn	F. E. Dudderar, Covina	28.36
170	do	Pacific Wood and Coal Co., San Diego.	26.26
	Guaranteed		26.48
171	Bradley's Nursery Stock	R. S. Thompson, Highland	27.56
172	do	F. E. Dudderar, Covina	28 08
173	do	Pacific Wood and Coal Co., San Diego.	27.45
	Guaranteed		26.48
174	Bradley's Orange and Lemon	Graham-Cope Com'l Co., Redlands	28 38
175	do	F. E. Dudderar, Covina	27.88
176	do	Pacific Wood and Coal Co., San Diego.	26 79
	Guaranteed		25.56
	The Armour Fertilizer Works, Los Angeles, Cal.		
177	Armour's Dried Blood	W. T. Henderson, Riverside	49.32
178	do	H. P. Greene, San Diego	46.37
	Guaranteed		46.80
179	Armour's Bone Meal	H. P. Greene, San Diego	29.89
	Guaranteed		26.95
155	Armour's Bone Blood and Potash	G. A. Hanson, Upland	32 89
180	do	H. P. Greene, San Diego	34.30
181	do	J. C. Boyd, Rialto	34.15
182	do	J. S. Edwards, Redlands	33.47
	Guaranteed		32.40

ANALYSES AND VALUATIONS.

Laboratory Number	Pounds per Hundred.												
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin	
	Available.	Insoluble.	Total	In Nitrates.	In Ammonia Salts.	Organic	Total	Guaranteed as Derived From.	Muriate	Sulfate	Total		
162	5.28	4.45	9.73	0.41	0.28	2.37	3.06		2.20			2.32	
	5.00	5.00	10.00				2.50	Nit., Bl., Bn., T., Bat. G.	2.50				
163	5.59	5.23	10.82	0.96		3.09	4.05		3.40	1.46	4.86	2.62	
	5.00	5.00	10.00				4.00	Nit., Bl., Bn., T.		5.00			
164	5.41	3.15	8.56	0.62	0.24	2.15	3.01			3.92		1.28	
	6.00	2.00	8.00				3.00	Nit., Bl., Bn., T.		4.00			
165	4.27	5.13	9.40	0.69		2.27	2.96			2.88			
	6.00	4.00	10.00	1.00		2.00	3.00	Nit., Bl., Bn., T.		3.00			
166	4.65	4.59	9.24	0.51		2.57	3.08		3.35	1.49	4.84	2.58	
	5.00	5.00	10.00				3.29	Nit., Bl., Bn., Bat. G.		5.00			
167	5.26	4.72	9.98	0.96		2.59	3.55			3.03			
	5.00	5.00	10.00	1.00		3.00	4.00	Nit, Bl., Bn., T.		3.00			
168	6.30	3.66	9.96	0.34		1.45	1.79			5.37			
	6.00	2.00	8.00				1.75	Nit., Bl., Bn., T.		6.00			
159	6.23	6.61	12.84	See foot note.		4.78							
	7.00	5.00	12.00			5.00							
169	8.74	1.48	10.22	3.16	0.25	0.60	4.01			3.61			
170	9.10	1.34	10.44	2.72		1.17	3.89			1.78			
	9.00	1.00	10.00				4.10	Nit., Bl., Bn., T., Bat. G., Fs. G.		1.50			
171	9.26	1.80	11.06	2.66	0.34	1.04	4.04			2.03			
172	9.69	1.07	10.76	2.65	0.49	1.02	4.16			1.97		0.80	
173	9.79	1.29	11.08	2.49		1.51	4.00			1.70			
	9.00	1.00	10.00				4.10	Nit., Bl., Bn., T., Bat. G., Fs. G.		1.50			
174	9.33	1.40	10.73	2.31	0.59	0.92	3.82			3.32			
175	9.49	1.06	10.55	2.73	0.49	1.00	4.22			1.87			
176	8.88	1.16	10.04	2.03	0.42	1.22	3.67			2.90		0.62	
	8.00	1.00	9.00				3.70	Nit., Bl., Bn., T., Bat. G., Fs. G.		3.00			
177						13.70							
178						12.88							
						13.00							
179	See foot note.		21.52	See foot note.		3.67							
			24.00			2.50							
155	8.31	1.02	9.33			4.18	4.18			6.48		0.66	
180	9.00	1.08	10.08	0.59	0.20	3.81	4.60			5.89		0.76	
181	7.67	2.64	10.31	0.72	0.26	3.13	4.11			7.91		0.86	
182	8.07	1.65	9.72	1.50		2.49	3.99			7.99		0.74	
	8.00	2.00	10.00				4.00	Nit., Bl., Bn., T.		7.00			

159— Nitrogen in fine Tankage, 3.86%; in medium Tankage, 0.92%.

179 — Phosphoric Acid in fine Bone, 15.06%; in medium Bone, 6.46%.
Nitrogen in fine Bone, 2.57%; in medium Bone, 1.10%.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	The Armour Fertilizer Works, Los Angeles, Cal.		
156	Armour's Fruit Special	G. A. Hanson, Upland	$20.37
183	do	J. S. Edwards, Redlands	23.57
184	do	H. P. Greene, San Diego	22.29
	Guaranteed		21.85
185	Armour's Fruit and Vine	H. P. Greene, San Diego	27.35
	Guaranteed		27.20
186	Armour's Lawn and Garden Fertilizer	W. T. Henderson, Riverside	23.94
	Guaranteed		23.50
187	Armour's Lawn and Garden Fertilizer	H. P. Greene, San Diego	21.68
	Guaranteed		23.50
188	Nitrate of Soda	H. P. Greene, San Diego	49.60
	Guaranteed		46.50
189	Armour's Orange Tree Manure	J. C. Boyd, Rialto	28.17
190	do	J. S. Edwards, Redlands	28.10
191	do	H. P. Greene, San Diego	28.80
	Guaranteed		25.30
192	Special Fertilizer	J. S. Edwards, Redlands	26.24
	Guaranteed		26.20
153	Special Fertilizer	A. Moncue, Palermo	26.14
	Guaranteed		26.00
	Balfour, Guthrie & Co., San Francisco, Cal.		
194	Thomas Phosphate Powder	John Niven, San Diego	18.34
	Guaranteed		18.47
195	Thomas Phosphate Powder	Balfour, Guthrie & Co's W'house, S. F.	17.29
	Guaranteed		17.34
	California Fertilizer Works, San Francisco, Cal.		
196	Fruit and Vine	Albert Bots, Palermo	32.02
	Guaranteed		28.46
197	Fruit, Orange and Vine	Albert Bots, Palermo	29.32
	Guaranteed		27.35
198	Nitrate of Soda	Cal. Fertilizer Works, W'house, S. F.	45.79
	Guaranteed		46.50
199	Nursery Stock	Albert Bots, Palermo	32.43
	Guaranteed		26.57
200	Sulfate of Potash	Albert Bots, Palermo	57.65
201	do	Cal. Fertilizer Works, W'house, S. F.	58.46
	Guaranteed		57.60
202	Thomas Phosphate Powder	Cal. Fertilizer Works, W'house, S. F.	17.75
	Guaranteed		17.10
154	Special Fertilizer	A. Moncue, Palermo	27.94
	Guaranteed		26.40

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	In Nitrates	In Ammonia Salts	Organic	Total	Guaranteed as Derived From	Muriate	Sulfate	Total	
156	7.64	1.21	8.85			1.46	1.46			4.57		
183	9.36	1.86	11.22	0.87	0.24	0.69	1.80		4.94	0.41	5.35	3.80
184	7.86	1.56	9.42	0.06	0.35	1.29	1.68			5.15		0.56
	8.00	2.00	10.00				1.50	Nit., Bl., Bn., T.		5.00		
185	6.66	0.34	7.00	0.87		1.58	2.45			9.13		0.86
	6.00	2.00	8.00				2.00	Nit., Bl., Bn., T.		10.00		
186	4.11	0.59	4.70	0.11		4.01	4.12			3.61		0.54
	4.00	1.00	5.00				4.00	Nit., Bl., Bn., T.		4.00		
187	4.62	0.92	5.54	0.83		2.59	3.42			3.36		0.52
	4.00	1.00	5.00	1.50		2.50	4.00	Nit., Bl., Bn., T.		4.00		
188				16.00				Guano.				
				15.00								
189	8.35	1.63	9.98	1.84		1.78	3.62			4.50		0.82
190	10.03	1.17	11.20	1.14	0.29	1.80	3.23			3.84		
191	8.26	2.83	11.09	1.44		2.28	3.72			4.19		0.56
	8.00	2.00	10.00				3.00	Nit., Bl., Bn., T.		4.00		
192	9.55	0.63	10.18	1.89		1.76	3.65			2.03		0.54
	8.00	2.00	10.00				4.00	Nit., Bl., Bn., T.		2.00		
153	9.99	1.63	11.62			3.97	3.97					
	10.00	1.00	11.00				4.00	Nit., Bl., Bn., T.				
194	See foot note.		19.18									
			19.45									
195	See foot note.		18.22									
			18.26									
196	7.17	2.53	9.70	1.35	0.58	1.06	2.99			10.13		1.06
	6.00	2.00	8.00				2.50	Nit., Animal matter.		10.00		
197	8.03	3.94	11.97	1.19	0.24	1.32	2.75			7.12		2.30
	8.00	2.00	10.00				2.50	Nit., Animal matter.		7.00		
198				14.77								
				15.00								
199	8.36	2.88	11.24	2.42	0.66	1.08	4.16			6.08		0.92
	8.00	2.00	10.00				4.15	Nit., Animal matter.		2.00		
200										48.04		18.52
201										48.72		1.36
										48.00		
202	See foot note.		18.52									
			18.00									
154	10.23	2.87	13.10		0.32	3.93	4.25					
	10.00	2.00	12.00				4.00	Animal matter				

194—Phosphoric Acid in fine Powder, 14.69%; in medium Powder, 4.49%.
195—Phosphoric Acid in fine Powder, 13.63%; in medium Powder, 4.59%.
202—Phosphoric Acid in fine Powder, 14.29%; in medium Powder, 4.23%.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	Chas. S. Hardy, San Diego, Cal.		
203	Hardy's Tankage	Chas. S. Hardy, San Diego	$30.25
	Guaranteed		23.55
	Maier Fertilizer Co., Los Angeles, Cal.		
204	"A A"	Manufacturers	31.03
	Guaranteed		29.50
205	"T"	Manufacturers	27.23
	Guaranteed		21.90
	Mapes Formula and Peruvian Guano Co., New York.		
206	Mapes Orange Tree Manure	J. J. Prendergast, Redlands	27.43
	Guaranteed		22.37
	Mohr & Yoerk Packing Co., Sacramento, Cal.		
207	M. and Y.	Manufacturers	30.81
	Guaranteed		32.17
	S. M. Neely, San Diego, Cal.		
157	Bird Guano	Call Fruit Co., Corona	49.66
208	do.	S. M. Neely, San Diego	46.10
	Guaranteed		33.96
	N. Ohlandt & Co., San Francisco, Cal.		
209	Ohlandt's Lawn Dressing	Manufacturers	29.39
	Guaranteed		28.50
	Southern California Fertilizer Co., Ontario, Cal.		
210	Fruit and Vine	Manufacturers	32.06
	Guaranteed		28.20
211	Lawn and Nursery	Manufacturers	31.99
	Guaranteed		28.00
212	Orange	Manufacturers	30.64
213	do	H. P. D. Kingsbury, Redlands	28.66
	Guaranteed		24.77
214	Orange Special	H. P. D. Kingsbury, Redlands	33.35
215	do	Manufacturers	32.28
	Guaranteed		29.96
	Swift & Co., Chicago.		
216	Swift's Ground Dried Blood	M. S. Ratliff, Colton	47.77
	Guaranteed		47.52
217	Swift's Special Bone Meal	M. S. Ratliff, Colton	29.76
	Guaranteed		26.14

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.												
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin.
	Available.	Insoluble.	Total.	In Nitrates.	In Ammonia Salts	Organic.	Total	Guaranteed as Derived From.	Muriate.	Sulfate.	Total.	
203	See foot note.		18.35			4.13						
			12.00			4.50						
204	6.95	4.24	11.19	See foot note.		6.36						
	7.00	5.00	12.00			6.00		Bl., Bn., T.				0.64
205	9.02	7.78	16.80	See foot note.		3.85						
	8.00	6.00	14.00			3.00		Bl., Bn., T.				
206	8.41	2.72	11.13	2.32	0.25	0.73	3.30			4.44		0.90
	6.00	2.00	8.00				3.29	Nit., Animal matter.		3.30		
207	See foot note.		25.98	See foot note.		3.31					0.14	
			26.61			3.10		Slaughter house refuse.			1.06	
157	10.79	0.82	11.61	1.07	2.57	7.78	11.42		2.03			2.56
208	8.81	0.76	9.57	0.43	2.25	8.46	11.14		2.03			2.70
	8.86	1.10	9.96	0.63	1.67	4.67	6.97		1.74			
209	8.47	0.15	8.62	3.84						6.04		
	8.00	1.00	9.00	4.00				Nit.		5.00		
210	10.41	1.79	12.20	0.94		2.35	3.29			6.27		0.54
	8.00	1.00	9.00				2.88	Nit., Bl., Bn., T.		7.00		
211	8.34	1.84	10.18	2.18		3.28	5.46			2.35		0.82
	8.00	1.00	9.00				5.00	Nit., Bl., Bn., T.		1.00		
212	9.71	1.48	11.19	1.45		2.76	4.21			3.32		0.60
213	8.50	1.35	9.85	1.48		2.67	4.15			3.20		0.54
	9.00	1.00	10.00				3.30	Nit., Bl., Bn., T.		2.00		
214	9.95	1.66	11.61	1.87		3.09	4.96			3.30		0.68
215	9.67	1.33	11.00	1.93		2.71	4.64			3.78		0.60
	10.00	1.00	11.00				4.12	Nit., Bl., Bn., T.		3.00		
216						13.27						
						13.20						
217	See foot note.		30.12	See foot note.		1.69						
			29.50			0.82						

203 } Phosphoric Acid in fine Tankage, 17.43%; in medium Tankage, 0.92%.
} Nitrogen in fine Tankage, 3.92%; in medium Tankage, 0.21%.

204—Nitrogen in fine Material, 4.61%; in medium Material, 1.75%.

205—Nitrogen in fine Material, 2.89%; in medium Material, 0.96%.

204 and 205 not being acidulated, are rated as Tankage.

207 } Phosphoric Acid in fine Material, 11.56%; in medium Material, 14.42%.
} Nitrogen in fine Material, 1.47%; in medium Material, 1.84%.

217 } Phosphoric Acid in fine Bone, 16.87%; in medium Bone, 13.25%.
} Nitrogen in fine Bone, 0.95%; in medium Bone, 0.74%.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer and Name of Brand.	From Whom Obtained.	Estimated Value per Ton
	Swift & Co., Chicago.		
218	Swift's Special Acidulated Bone	M. S. Ratliff, Colton	$26.44
	Guaranteed		25.47
219	Swift's Diamond "A"	M. S. Ratliff, Colton	30.41
	Guaranteed		30.52
220	Swift's Diamond "E"	C. B. Smith, Redlands	33.09
221	do	M. S. Ratliff, Colton	31.97
	Guaranteed		30.51
222	Swift's Diamond "G"	M. S. Ratliff, Colton	32.94
	Guaranteed		31.28
	Union Fertilizer Co., Los Angeles, Cal.		
223	Bone Meal	J. W. Freeman, Upland	27.69
224	do	W. T. Bill, Redlands	28.46
	Guaranteed		26.90
225	Fruiting Fertilizer	J. W. Freeman, Upland	25.96
	Guaranteed		23.87
226	Fruiting Fertilizer	W. T. Bill, Redlands	33.62
	Guaranteed		32.60
227	Special Fruiting Fertilizer	J. W. Freeman, Upland	27.33
	Guaranteed		29.08
229	Nursery Fertilizer	J. W. Freeman, Upland	30.37
230	do	W. T. Bill, Redlands	21.20
	Guaranteed		30.24
231	Orange and Lemon Fertilizer	J. W. Freeman, Upland	25.64
232	do	W. T. Bill, Redlands	25.48
	Guaranteed		25.00
	West Coast Fertilizer Works, Los Angeles, Cal.		
139	Special	J. E. Davis, Redlands	23.78
233	do	W'house Wilcox-Rose Mercantile Co., Colton	24.36
	Guaranteed		24.85
	Western Meat Co., San Francisco.		
234	W. M. Co. Tankage	Manfacturers	35.96
	Guaranteed		36.25

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.											
	Phosphoric Acid.			Nitrogen.					Potash.			Chlorin...
	Available.	Insoluble.	Total.....	In Nitrates.	In Ammonia Salts	Organic...	Total.....	Guaranteed as Derived From.	Muriate...	Sulfate...	Total. ...	
218	16.59	3.60	20.19	------	------	1.35	------	------ ----- ---	------	------	------	------
	18.00	2.00	20.00	------	------	0.82	------	---- ----- ------	------	------	------	------
219	14.81	3.36	18.17	------	-----	3.13	-----	This brand acidulated.	------	------	------	------
	15.00	2.00	17.00	------	------	3.29	------	Bl., Bn., T. ...	----	------	-----	------
220	See foot	note.	18.10	See foot	note.	5.30	------	------ -------	------	------	------	1.00
221	See foot	note.	17.86	See foot	note.	4.95	------	------ ----- -----	------	------	------	0.90
	------	------	19.00	------	-----	4.94	------	Bl., Bn., T. ...	------	------	------	------
222	See foot	note.	18.84	See foot	note.	3.22	------	---- ----- -----	------	4.67	------	0.66
	------	- ---	19.00	------	------	3.25	-----	Bl., Bn., T. ...	------	5.00	------	------
223	See foot	note.	21.10	See foot	note.	3.91	------	------ ----- ----	------	------	------	------
224	See foot	note.	21.82	See foot	note.	4.10	------	---- ------ -----	-----	------	------	------
	-----	------	22.00	------	-----	3.00	------	------ ----- ----	------	------	------	------
225	9.55	2.53	12.08	0.46	0.90	1.40	2.76	---- ------ ----	------	3.05	------	0.76
	7.00	2.00	9.0C	0.75	0.60	1.65	3.00	Nit., Guano, Bn., T.	-----	3.50	------	------
226	9.70	1.48	11.18	0.98	0.89	2.71	4.58	------ ------ --	------	4.59	-- ---	0.74
	10.00	2.00	12.00	------	------	------	4.00	Guano	-----	5.00	------	------
227	8.21	1.28	9.49	0.81	0.74	2.05	3.60	---- ----- ------ -	------	3.74	------	------
	8.00	2.00	10.00	1.00	0.75	2.25	4.00	Nit., Guano, Bn., T.	------	4.00	------	------
229	6.80	1.56	8.36	0.56	0.90	4.11	5.47	------ ---- -----	------	1.72	------	0.94
230	4.94	1.16	6.10	0.84	0.58	2.44	3.86	---- ----- ---	------	1.22	------	0.64
	7.00	2.00	9.00	------	------	-----	5.60	Nit., Guano, T.	-----	1.50	-----	------
231	8.33	2.11	10.44	0.45	0.55	1.96	2.96	------ ---- -----	------	3.63	------	0.60
232	8.12	2.02	10.14	0.30	0.69	1.96	2.95	---- ---- - -----	------	3.71	------	------
	8.00	2.00	10.00	-----	-----	-----	3.00	Guano, T. ----	------	3.50	------	------
139	12.70	1.59	14.29	-----	------	2.14	-----	------ ---- -----	------	0.21	------	------
233	13.51	1.80	15.31	0.12	-----	1.88	2.00	---- -------	------	0.21	------	------
	12.00	1.00	13.00	------	------	------	2.50	Nit., Bl., Bn., T.	------	1.00	------	------
234	See foot	note.	8.85	See foot	note.	8.75	------	------ ------ ---	------	------	------	------
	------	------	8.50	-----	------	9.50	------	---- ------ -----	------	------	------	------

220, 221, and 222 not being acidulated, are rated as Tankage.

220 { Phosphoric Acid in fine Material, 14.84%; in medium Material, 3.26%.
Nitrogen in fine Material, 4.35%; in medium Material, 0.95%.

221 { Phosphoric Acid in fine Material, 14.82%; in medium Material, 3.04%.
Nitrogen in fine Material, 4.11%; in medium Material, 0.84%.

222 { Phosphoric Acid in fine Material, 16.96%; in medium Material, 1.88%.
Nitrogen in fine Material, 2.90%; in medium Material, 0.32%.

223 { Phosphoric Acid in fine Bone, 6.33%; in medium Bone, 14.77%.
Nitrogen in fine Bone, 1.17%; in medium Bone, 2.74%.

224 { Phosphoric Acid in fine Bone, 5.46%; in medium Bone, 16.36%.
Nitrogen in fine Bone, 1.03%; in medium Bone, 3.07%.

234 { Phosphoric Acid in fine Tankage, 6.64%; in medium Tankage, 2.21%.
Nitrogen in fine Tankage, 6.56%; in medium Tankage, 2.19%.

Two samples of gypsum, registered by the Agricultural Chemical Works, Los Angeles, Cal., were analyzed. The results are given below.

Sample No. 160, collected from Patterson & Scott, Pomona.

	Hydrated Calcium Sulfate.
Found	61.14 %
Guaranteed	61.00 %

Sample No. 161, collected from Pioneer Fruit Co., Sacramento.

	Hydrated Calcium Sulfate.
Found	63.28 %
Guaranteed	61.00 %

REPORTS OF SALES.

The sworn statements of manufacturers and dealers, required by Section 8 of the law, showed sales of fertilizers of all kinds for the year ending June 30, 1904, amounting to 9,790 tons.

REPORTS AND BULLETINS AVAILABLE FOR DISTRIBUTION.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1898. Partial Report of Work of Agricultural Experiment Station for the years 1895-96 and 1896-97.
1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-1903.

BULLETINS.

Reprint. Endurance of Drought in Soils of the Arid Region.
No. 125. Australian Saltbush.
128. Nature, Value, and Utilization of Alkali Lands.
129. Report of the Condition of Olive Culture in California.
131. The Phylloxera of the Vine.
132. Feeding of Farm Animals.
133. Tolerance of Alkali by Various Cultures.
135. The Potato-Worm in California.
137. Pickling Ripe and Green Olives.
138. Citrus Fruit Culture.
139. Orange and Lemon Rot.
140. Lands of the Colorado Delta in Salton Basin, and Supplement.
141. Deciduous Fruits at Paso Robles.
142. Grasshoppers in California.
143. California Peach-Tree Borer.
144. The Peach-Worm.
145. The Red Spider of Citrus Trees.
146. New Methods of Grafting and Budding Vines.
147. Culture Work of the Substations.
148. Resistant Vines and their Hybrids.
149. California Sugar Industry.
150. The Value of Oak Leaves for Forage.
151. Arsenical Insecticides.
152. Fumigation Dosage.
153. Spraying with Distillates.
154. Sulfur Sprays for Red Spider.
155. Directions for Spraying for the Codling-Moth.
156. Fowl Cholera.
157. Commercial Fertilizers.
158. California Olive Oil; its Manufacture.
159. Contribution to the Study of Fermentation.
160. The Hop Aphis.
161. Tuberculosis in Fowls.

CIRCULARS.

No. 1. Texas Fever.
2. Blackleg.
3. Hog Cholera.
4. Anthrax.
5. Contagious Abortion in Cows.
6. Methods of Physical and Chemical Soil Analysis.
7. Remedies for Insects.
No. 8. Laboratory Method of Water Analysis.
9. Asparagus Rust.
10. Reading Course in Economic Entomology.
11. Fumigation Practice.
12. Silk Culture.

Copies may be had by application to the Director of the Experiment Station, Berkeley, California.

UNIVERSITY OF CALIFORNIA PUBLICATIONS.

COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

BULLETIN No. 173.

(Berkeley, Cal., December 31, 1905.)

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1906

BENJAMIN IDE WHEELER, Ph.D., LL.D., *President of the University*

EXPERIMENT STATION STAFF (JANUARY, 1906).

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E. J. WICKSON, M.A., *Acting Director and Horticulturist.*
W. A. SETCHELL, Ph.D., *Botanist.*
ELWOOD MEAD, M.S., C.E., *Irrigation Engineer.*
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R. H. LOUGHRIDGE, Ph.D., *Agricultural Geologist and Soil Physicist.* (*Soils and Alkali.*)
M. E. JAFFA, M.S., *Assistant Chemist.* (*Foods, Nutrition.*)
G. W. SHAW, M.A., Ph.D., *Assistant Chemist.* (*Starches, Oils, Beet-Sugar.*)
GEORGE E. COLBY, M.S., *Assistant Chemist.* (*Fruits, Waters, Insecticides.*)
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WARREN T. CLARKE, B.S., *Assistant Entomologist and Asst. Supt. Farmers' Institutes.*
H. M. HALL, M.S., *Assistant Botanist.*
GEORGE ROBERTS, M.S., *Assistant Chemist, in charge of Fertilizer Control.*
C. M. HARING, D.V.M., *Assistant Veterinarian and Bacteriologist.*
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HENRY WIGHTMAN, *In charge,* } University Forestry Station, Chico.
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The Station publications (REPORTS AND BULLETINS), *so long as available, will be sent to any citizen of the State on application.*

COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

This report gives the results of fertilizer inspection work for the period from July 1 to December 31, 1905. Below is given a list of the twenty-three manufacturers of, and dealers in, commercial fertilizers, who have obtained certificates of registration under the provisions of the California fertilizer law for the year beginning July 1, 1905. A list is also given of brands of fertilizers and fertilizing materials offered for sale by the registered manufacturers and dealers.

Agricultural Chemical Works, Los Angeles, Cal.

Registration No. 8.

Apricot.
Bat Guano.
Berry.
Blood.
Bone Meal.
Grape.
Lawn.
Muriate of Potash.
Nitrate of Soda.
No. 1 Orange and Lemon.
Nursery.
Olive.
Peach.
Potato.
Prune.
Riverside Special.
Rose.
Special Orange and Lemon for Heavy Soil.
Special Orange and Lemon for Light Soil.
Special Orange and Lemon for Non-fruiting Trees.
Sulfate of Potash.
Superphosphate.
Tankage.
Vegetable.
Walnut and Almond.

Special mixtures to order of consumers.

American Agricultural Chemical Co., California Works, Los Angeles, Cal.

Registration No. 1.

Acid Phosphate.
Bradley's Fruit and Vine.
Bradley's Special Fruit and Vine.
Bradley's Lawn.
Nitrate of Soda.
Bradley's Nursery Stock.
Bradley's Orange and Lemon.
Sulfate of Potash.
Bradley's California Vegetable.

The Armour Fertilizer Works, Los Angeles, Cal.

Registration No. 7.

Armour's Acidulated Bone Meal.
Armour's Bone Meal.
Armour's Bone Flour for Flowers.
Armour's Bone, Blood and Potash.
Armour's Concentrated Superphosphate.
Armour's Dried Blood.
Armour's Flower and Fern Food.
Armour's Fruit Special.
Armour's Fruit and Vine Fertilizer.
Armour's Lawn and Garden Fertilizer.
Armour's Nitrate of Soda.
Armour's Orange Tree Manure.
Armour's Pea Special.
Armour's Special 5-8-2.
Armour's Sulfate of Potash.
Armour's Tankage.

Special mixtures to order of consumers.

Balfour, Guthrie & Co., San Francisco, Cal.

Registration No. 10.

Muriate of Potash.
Nitrate of Soda.
Sulfate of Potash.
Thomas Phosphate Powder.

California Fertilizer Works, Inc., San Francisco, Cal.

Registration No. 3.

Blood.
Double Manure Salt.
Fish.
Fruit and Vine.
Special Fruit and Vine.
Fruit, Orange and Vine.
Guano.
High Grade Ammoniated Bone Superphosphate.
High Grade Bone Meal.
Hop.
Kainit.
Lemon Tree (M).
Muriate of Potash.
Nitrate of Soda.
Nursery Stock.
Odorless Lawn Dressing.
Orange and Lemon.
Orange Tree.
Orange Tree (B).
Special Orange Tree.
Peach.
Special Fertilizer with Iron Sulfate.
Sulfate of Ammonia.
Sulfate of Potash.
Tankage.
Thomas Phosphate Powder.
Truck and Berry.
Special Fertilizer No. 1.
Special Fertilizer No. 2.
Special Fertilizer No. 3.
Special Fertilizer No. 4.
Special Fertilizer No. 5.
Special Fertilizer No. 6.

Special mixtures to order of consumers.

Columbus C. Chapman, Los Angeles, Cal.

Registration No. 23.

Acid Phosphate.
Bat Guano.
Blood.
Bone Meal.
Cotton Seed Meal.
Double Superphosphate.
Fish Guano.
Muriate of Potash.
Nitrate of Soda.
Sulfate of Ammonia.
Sulfate of Potash.
Tankage.
Thomas Phosphate Powder.

Special mixtures to order of consumers.

Cudahy Packing Co., South Omaha, Neb.

Registration No. 16.

Cudahy's Blood and Bone.

Hawaiian Fertilizer Co , Ltd., San Francisco, Cal.

Registration No. 19.

Bat Guano.
Blood.
Bone Meal.
Muriate of Potash.
Nitrate of Soda.
Sulfate of Potash.
Superphosphate.
Tankage.
Thomas Phosphate Powder.

Special mixtures to order of consumers.

R. A. Holcombe & Co., San Francisco, Cal.

Registration No. 27.

Nitrate of Soda.

The Maier Fertilizer Co., Los Angeles, Cal.

Registration No. 6.

AA.

T.

Special mixtures to order of consumers.

Mapes Formula and Peruvian Guano Co., New York.

Registration No. 12.

Mapes Fruit and Vine Manure.
Mapes Vegetable Manure.
Mapes Orange Tree Manure.

The Mountain Copper Co., San Francisco, Cal.

Registration No. 28.

Superphosphates.
" Mixed Fertilizers of various compositions.
" Special mixtures to order of consumers.

S. M. Neely, San Diego, Cal.

Registration No. 20.

Bird Guano.

Nelson Morris & Co., Chicago, Ill.

Registration No. 26.

Big Two.
Big Three.
Big Four.
Big Five.
Big Six.
Tankage.

Special mixtures to order of consumers.

Oakland Meat and Packing Co., Stock Yards, Cal.

Registration No. 24.

Special Fertilizer.

Pacific Bone, Coal and Fertilizing Co., San Francisco, Cal.

Registration No. 14.

Acidulated Bone Meal.
Ammoniated Dissolved Bone Meal.
Pure Dissolved Bone Meal.
Pure Bone Meal.
Ceres Brand.
Citrona Brand.
EE.
Double Superphosphate.
Muriate of Potash.
Nitrate of Soda.
Pomona Brand.
Sulfate of Potash.
Lupine Brand.
Thomas Phosphate Powder.

Pacific Guano and Fertilizer Co., San Francisco, Cal.

Registration No. 4.

Dissolved Bone Meal.
Raw Bone Meal.
Steamed Bone Meal.
Double Manure Salt.
Dried Blood.
Fish Scrap.
(OO) Grape Fertilizer.
Kainit.
Ohlandt's Lawn Dressing.
Muriate of Potash.
Nitrate of Soda.
(N) Orange and Lemon.
(NN) Orange and Lemon.
(O) Peach, Almond, and Prune.
Sulfate of Ammonia.
Sulfate of Potash.
Superphosphate.
Double Superphosphate.
Tankage No. 1.
Tankage No. 2
Thomas Phosphate Powder.
(OOO) Vegetable Grower.

Carroll B. Smith, Redlands, Cal.

Registration No. 25.

Queen Quality.
Golden Fruit.
Green Leaf.

Southern California Fertilizer Co., Ontario, Cal.

Registration No. 13.

Animal Tankage.
Double Superphosphate.
Fruit and Vine.
Ground Dried Blood.
Ground Steamed Bone.
Lawn and Nursery.
Lemon.
Nitrate of Soda.
Ontario Special.
Orange.
Orange Special.
Orange and Lemon.
Sulfate of Potash.

Special mixtures to order of consumers.

Swift & Co., Chicago, Ill.

Registration No. 5.

Swift's Diamond "A" Fertilizer.
Swift's Diamond "B" Fertilizer.
Swift's Diamond "C" Fertilizer.
Swift's Diamond "D" Fertilizer.
Swift's Diamond "E" Fertilizer.
Swift's Diamond "G" Fertilizer.
Swift's Ground Dried Blood.
Swift's Special Acidulated Bone.
Swift's Special Bone Meal.

Union Fertilizer Co., Los Angeles, Cal.

Registration No. 9.

Acidulated Bone.
Blood.
Blood and Bone.
Bone Meal.
Steamed Bone Meal.
Superphosphate.
Fruiting Fertilizer.
Special Fruiting Fertilizer.
Lawn Fertilizer.
Nitrate of Soda.
Nursery Fertilizer.
Orange and Lemon Fertilizer.
Sulfate of Potash.
Tankage.
Special fertilizer to order of consumers.

Western Meat Co., San Francisco, Cal.

Registration No. 11.

W. M. Co. Bone Meal.
W. M. Co. Tankage.
Special mixtures to order of consumers.

The Woodbridge Chemical Co., San Bernardino, Cal.

Registration No. 15.

Apricot.
Bone Meal.
Citrus A.
Citrus B.
Grape.
Nitrate of Soda.
Orange and Lemon No. 1.
Peach and Prune.
Lawn and Rose.
Sulfate of Potash.
Tankage.
Vegetable Fertilizer.
Vegetable Fertilizer for Leguminous Crops.
Walnut.

One hundred and thirty-eight samples of registered fertilizers and fertilizing materials have been received at the laboratory during the period covered by this report, all of which have been analyzed and are herein reported. Of this number, 128 were taken by deputy inspectors and 10 were sent by farmers under the two-dollar fee provision of the fertilizer law.

The following classification may be made of the above-named samples:

Complete Fertilizers	92
Bone Meal and Tankage	31
Nitrogenous Superphosphates	3
Superphosphate	2
Sulfate of Potash	3
Thomas Phosphate Powder	1
Nitrogenous only. (Four samples of dried blood)	5
Bat Guano	1
Total	138

Beginning with July 1, 1905, the plan was adopted of taking samples of every lot of goods found by the inspectors. This accounts for the large number of samples of some brands in this report.

DEFICIENCIES.

In the analyses of registered samples reported, the following number of deficiencies greater than allowed by law occur:

Available Phosphoric Acid (total when available is not guaranteed)	17
Total Nitrogen	13
Potash	13
In valuation	8

ANALYSES FOR CONSUMERS.

Any user of fertilizers may, by paying the fee of two dollars specified by Section 4 of the fertilizer law, have a sample of his material analyzed. This fee is not to be regarded as paying the cost of the analysis. It is a nominal charge made to prevent the sending of samples through curiosity, as is always the case when analyses are made free of charge.

The sample should be drawn from not less than ten packages, if the lot is five tons or less; if the lot is over five tons, the sample should be drawn from not less than twenty packages. The larger the number of packages sampled, the more representative the sample will be. The sample drawn as specified above should be thoroughly mixed, great care being exercised to prevent the separation of coarse and fine materials. Not less than one quart should be taken from this sample, to be sent to the Station for analysis. Whenever possible the sampling should be done in the presence of the agent, who should sign, as a witness, the certificate given below. If the sample is not drawn in the presence of the agent, it should be drawn in the presence of some other person, who should sign the certificate as a witness.

Samples for consumers will be given preference in the laboratory and the results will be reported as soon as possible. The sample should be sent, if possible, in time to receive the report before the fertilizer is used, in order that recourse may be had to the original packages in case of controversy with the manufacturer.

The form of certificate given below should be used in sending samples for analysis. Blank forms will be furnished upon application. All samples should be marked in some way so that they may be identified. Samples should be sent prepaid, addressed to the Fertilizer Control, Experiment Station, Berkeley, and should bear the name and address of the sender. Bank checks and money orders should be made payable to "The Regents of the University of California." Letters, certificates, and remittances should not be enclosed with the samples, but mailed separately. When the report of analysis is received, a tag or label taken from one of the bags sampled should at once be sent to the Station, and the name and address of the agent from whom the

goods were purchased should be given. Analyses will be made only for those who purchase fertilizers for their own use. Any one refusing to send a tag or label as specified above will be excluded from further privileges under the above provisions.

CERTIFICATE FOR CONSUMER'S ANALYSIS.

Director Agricultural Experiment Station, University of California, Berkeley, Calif.

This is to certify that I am not a dealer in, or agent for the sale of any fertilizer, and that the fertilizer, a sample of which I have sent you for analysis, was purchased by me_____, 190 .., for my own use and not for sale.

I further certify that the amount purchased was_____tons and that the sample was drawn from_____packages and was thoroughly mixed.

Upon receipt of the analysis from you, I agree to furnish you with a tag or label taken from one of the packages sampled, and the name and address of the firm or agent of whom the fertilizer was purchased. I enclose two dollars analysis fee.

(Signature)_____

(P. O. Address)_____

(Signature of Witness) (Date)_____

VALUATION OF FERTILIZERS.

The "agricultural value" and the "commercial value" of fertilizing materials are not synonymous terms. The agricultural value of a fertilizer is determined by the increase and quality produced by it in the crop. The commercial value of a fertilizer is determined by the cost of the materials which enter into its composition. A fertilizing material of high commercial value may have a low agricultural value on a particular soil or crop. On another soil or crop the same material may have a high agricultural value.

In calculating the values given in this report the Experiment Station does not undertake to say what the retail prices of fertilizers should be in this State. The values given are for the amounts of the unmixed raw materials of good quality represented by the analyses, and do not take into account the cost of grinding, mixing, bagging, insurance, drayage, agent's commission, and other expenses of the manufacturer. Hence the valuations in this report are generally lower than the retail prices of fertilizers. The schedule of values used is given below. They represent, as nearly as can be determined, the prices at which fertilizing ingredients in raw materials of good quality can be bought at retail for cash at the warehouses in our largest markets like San Francisco. It is a difficult matter to get quotations on fertilizing materials in our market that agree closely enough to serve as a basis for a schedule that represents the actual market conditions. Taken as a whole, it is believed that the schedule used is fairly close to the market conditions.

The estimation of values is not without its use, even if the schedule used does not represent the actual market conditions. In the first place, a comparison of values calculated upon the guaranty and the

analysis shows whether the goods have the commercial value represented by the guaranteed analysis. In the second place, the calculation of values upon different guaranteed analyses enables the purchaser to determine which dealer offers him plant food at the lowest price, provided, of course, that the materials offered are of the same quality.

In reading the report of analyses, the column of values is the last one to be considered. The first things to consider are the materials used and the analysis as compared with the guaranty. From the very nature of the case the analysis must differ somewhat from the guaranty, but the variation should not be so great as to change the nature of the fertilizer. Such a variation might take place, and at the same time the value calculated upon the guaranty be greater than the value calculated upon the analysis. Suppose, for example, that a fertilizer should be guaranteed to have the composition indicated by the first column below, and upon analysis it should show the composition indicated by the second column.

	Guaranteed.	Found.
Available Phosphoric Acid	8 per cent.	10 per cent.
Insoluble Phosphoric Acid	2 "	2 "
Total Phosphoric Acid	10 "	12 "
Nitrogen	3 "	3 "
Potash	5 "	3 "

According to the schedule of values now in use these two compositions would have the same commercial value, yet they are essentially different. Such variations as the above are sometimes met with.

SCHEDULE OF TRADE VALUES.

	Cents per Pound.
Phosphoric Acid.	
Available (water- and citrate-soluble)	6
Insoluble in mixed fertilizers	2½
Insoluble in plain acid phosphate	0
In fine* bone and tankage	4½
In medium* bone and tankage	3½
In fine* Thomas phosphate powder	5†
In medium* Thomas phosphate powder	3†
Nitrogen.	
In ammonia salts	18
In nitrates	16½
Organic in—	
Blood	18½
Mixed fertilizers	18
Fine* bone and tankage	18
Medium* bone and tankage	14
Potash.	
From sulfate	6
From muriate	5

*Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas phosphate powder by a 100-mesh sieve.

†This method of giving a valuation to Thomas phosphate powder is temporary, awaiting the adoption of methods by the Association of Official Agricultural Chemists.

To calculate the value per ton of a fertilizer, multiply the pound value of each ingredient by 20, then multiply these products by the percentages of the several ingredients, and add the results.

For example:

	Value per lb.	Analysis Per cent.	
Available phosphoric acid	6 cents	× 20 × 8.00 =	$9.60
Insoluble phosphoric acid	2½ "	× 20 × 2.00 =	1.00
Total phosphoric acid			10.00
Nitrogen in nitrates	16½ cents	× 20 × 1.50 =	4.95
Organic nitrogen	18 "	× 20 × 2.50 =	9.00
Total nitrogen			4.00
Potash from sulfate	6 cents	× 20 × 4.00 =	4.80
Value per ton			$29.35

IMPORTANT.

Caution to Purchasers of Fertilizers.

Farmers are requested not to purchase fertilizers that are not labeled to meet the requirements of law, and not to attempt to purchase them from any one but registered dealers or their authorized agents. Any farmer who purchases fertilizers under any other conditions does not deserve the protection of the law, and the manufacturer or dealer who does not label his goods according to the full requirements of the law is liable to prosecution and should in nowise be patronized by farmers. It is quite liable to happen, and does happen, that now and then a manufacturer may miss his guaranty without intending to do so, but it is impossible that he would have his labels printed in non-conformity to the law without doing so either intentionally or through gross carelessness. Farmers can render great assistance in enforcing the law by observing the above caution.

Every bag or package of fertilizer and fertilizing material, whether a regular brand or a special mixture, should carry a label or tag bearing the following:

1. Name and address of manufacturer and place of manufacture.
2. Registration number.
3. Name or brand of fertilizer.
4. Guaranteed analysis, giving percentage of
   Available phosphoric acid;
   Insoluble phosphoric acid;
   Total phosphoric acid.
   Nitrogen in nitrates;
   Nitrogen in ammonia salts;
   Organic nitrogen;
   Total nitrogen.
   Potash.
   Or such of these ingredients as may be present.
5. A statement of the materials from which the above ingredients are derived.

In case of bone meal, tankage, and Thomas phosphate powder, a guaranty of available phosphoric acid is not required when these materials are not acidulated.

No dealer or manufacturer, except those who have certificates of registration from the University of California, and their authorized agents, can legally sell fertilizers in this State. No person or company has any right to use any registration number except in connection with the firm name to which the registration certificate of such number has been issued; and no person or company to whom a registration number has been assigned has any right to give any other person or company permission to use said registration number, and any number so used is a fraud. No agent has any right to use his principal's registration number in connection with his own name.

REPORT OF ANALYSES.

The following tables give the results of all analyses made from July 1 to December 31, 1905.

Available phosphoric acid is not determined in bone meal, tankage, and Thomas phosphate powder, unless requested. The fineness of these materials is determined, fine and medium bone being separated by a sieve of 50 meshes to the inch; tankage by a 25-mesh sieve; and Thomas phosphate powder by a 100-mesh sieve.

Some fertilizers containing all three ingredients are rated as tankage, because they are non-acidulated tankage products with potash salts added, and do not carry a guaranty of available phosphoric acid.

Nitrogen in ammonia salts will, in some cases, be found reported when nitrogen in this form is not guaranteed. In some of such cases this form of nitrogen is produced by conversion of organic nitrogen during process of manufacture, and is not to be considered a deviation from guaranty of materials used. This form is not reported separately when less than 0.20 per cent, unless it has been guaranteed, but is included in the total. Guanos carry more or less nitrogen in nitrates and ammonia salts, and when any appreciable quantity of guano is used the manufacturer should take into account the fact that some nitrogen will show as nitrates and ammonia salts. The failure to take this into consideration may perhaps account for the appearance of these forms of nitrogen in some samples in which only organic nitrogen was guaranteed.

The percentage of chlorin is given when it exceeds 0.50 per cent. It is a matter of only technical interest whether chlorin present is from muriate of potash, kainit, or from common salt that may be in some of the materials used. If a manufacturer uses sulfate of potash and uses

a tankage with it containing a large amount of chlorin, from a practical standpoint he has lowered the grade of his fertilizer just as much as if he had used muriate of potash instead of sulfate of potash. Chlorin from all other sources is as objectionable as from muriate of potash. However, if muriate of potash is found when sulfate is guaranteed, the fact will be published.

The following abbreviations are used in the tables: Bl = blood; Bn = bone; Fs = fish; G = guano; Super = superphosphate; T = tankage.

Guaranties are entered in *italics*. Deficiencies greater than allowed by law are entered in bold type.

ANALYSES AND VALUATIONS.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Agricultural Chemical Works, Los Angeles, Cal.		
509	Bat Guano	W. H. Collins, Covina	$27.79
	Guaranteed		*24.08*
413*	Fine Bone	E. A. Moore, Redlands	25.89
	Guaranteed		*24.58*
414*	Fine Bone	E. A. Moore, Redlands	29.18
415*	do	G. A. Herdeg, Riverside	26.71
	Guaranteed		*24.13*
416	Lawn Fertilizer	E. A. Moore, Redlands	18.36
	Guaranteed		*19.85*
417	Orange and Lemon No. 1	E. A. Moore, Redlands	28.62
452	do	William Funk, Corona	30.19
	Guaranteed		*28.60*
510	Special Orange and Lemon for Heavy Soil	Manufacturer	22.06
511	do	W. H. Collins, Covina	23.62
	Guaranteed		*23.30*
466	Special Orange and Lemon for Light Soil	Thomas Moffatt, Rialto	23.40
512	do	W. H. Collins, Covina	23.72
540	do	L. S. Taylor, San Dimas	22.02
	Guaranteed		*23.50*
418	Special Orange and Lemon	E. A. Moore, Redlands	25.49
	Guaranteed		*24.95*
419	Special Orange and Lemon	G. A. Herdeg, Riverside	24.86
420	do	G. A. Herdeg, Riverside	25.22
	Guaranteed		*25.00*
513	Special Orange and Lemon	E. W. Hart, San Dimas	21.77
	Guaranteed		*22.05*
514	Special Orange and Lemon	W. C. Barth, Corona	27.58
	Guaranteed		*24.20*
421	Riverside Special Orange and Lemon	E. A. Moore, Redlands	26.33
422	do	G. A. Herdeg, Riverside	27.39
	Guaranteed		*26.20*
423*	Tankage	E. A. Moore, Redlands	27.86
	Guaranteed		*28.25*
	American Agricultural Chemical Co., Los Angeles, Cal.		
526	Acid Phosphate	A. P. Johnson, Riverside	22.30
	Guaranteed		*19.20*

*413—34 per cent fine.
*414—14 per cent fine.
*415—27 per cent fine.
*423—64 per cent fine.

ANALYSES AND VALUATIONS.

Laboratory Number	Pounds Per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates.	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
509	6.14	1.74	7.88		1.51	0.68	3.21		5.40			0.48	
	6.00	*2.50*	*8.50*				*4.25*		*4.25*			*0.56*	
413			20.03				3.42		3.42				
			20.00				*3.00*		*3.00*				
414			21.90				4.20		4.20				
415			**18.94**				4.12		4.12				
			22.00				*2.50*		*2.50*				
416	4.53	5.61	10.14		0.32		1.73		**2.05**	2.86			2.08
	5.00	*5.00*	*10.00*	Bn. T. Super	*0.50*		*2.00*	*Bl, Bn, T	*2.50*	*2.50*			
417	4.73	4.54	9.27		0.86		3.16		4.02		5.38		0.78
452	5.19	5.40	10.59		1.62		2.53		4.25		5.67		0.68
	5.00	*5.00*	*10.00*	Bn, T, Super	*1.00*		*3.00*	Bl, Bn, T	*4.00*		*5.00*		
510	5.17	4.25	9.42		0.52		2.39		2.91		2.84		
511	6.06	4.50	10.56		0.70		2.25		2.95		3.07		
	6.00	*4.00*	*10.00*	Bn, T, Super	*1.00*		*2.00*	Bl, Bn, T	*3.00*		*3.00*		
466	5.70	2.30	8.00		1.02		1.95		2.97		4.19		
512	6.07	2.31	8.38		0.67		2.35		3.02		3.84		0.58
540	**4.63**	2.11	6.74		1.16		1.88		3.04		4.00		0.70
	6.00	*2.00*	*8.00*	Bn, T, Super	*1.00*		*2.00*	Bl, Bn, T	*3.00*		*4.00*		
418	4.50	4.29	8.79				1.60		1.60		10.15		
	4.00	*5.50*	*9.50*	Bn, T, Super			*1.50*	Bl, Bn, T	*1.50*		*10.00*		
419	*6.00	4.18	10.18		0.85		2.05		2.90		**4.48**		0.58
420	6.14	3.48	9.62		0.89		2.01		2.90		4.94		
	5.00	*5.00*	*10.00*	Bn, T, Super	*1.00*		*2.00*	Bl, Bn, T	*3.00*		*5.00*		
513	7.40	5.26	12.66				2.22		2.22		**1.89**		
	7.50	*4.50*	*12.00*	Bn, T, Super			*2.00*	Bl, Bn, T	*2.00*		*3.00*		
514	11.01	8.65	19.66				2.30		2.30		1.47		
	10.00	*10.00*	*20.00*	Bn, Super			*2.00*	Bn	*2.00*				
421	4.85	4.16	9.01		0.60		3.49		4.09		3.26		0.58
422	5.78	3.99	9.77		0.87		3.25		4.12		3.24		0.54
	5.00	*5.00*	*10.00*	Bn, T, Super	*1.00*		*3.00*	Bl, Bn, T	*4.00*		*3.00*		
423	8.02	8.87	16.89				4.17		**4.17**				
	6.00	*9.00*	*15.00*				*5.00*		*5.00*				
526	18.58	0.56	19.14										
	16.00												

*416—Contains Bat Guano.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	American Agricultural Chemical Co., Los Angeles, Cal.		
424	Bradley's Nursery Stock	Eben Boalt, Palermo	$27.86
425	do	Graham-Cope Com'cial Co., Redlands	26.92
495	do	T. P. Drinkwater, Corona	26.25
496	do	E. C. Robinson, Pomona	28.05
515	do	R. H. Hill, San Fernando	28.78
516	do	Pacific Wood and Coal Co., San Diego	28.04
517	do	W. L. Hale, Fullerton	27.48
527	do	S. H. Barrett, East Highlands	28.39
528	do	A. P. Johnson, Riverside	28.89
529	do	R. S. Thompson, Highlands	29.29
547	do	H. H. Garstin, Redlands	27.74
	Guaranteed		*27.11*
426	Bradley's Orange and Lemon	Graham-Cope Com'cial Co., Redlands	27.56
427	do	Eben Boalt, Palermo	29.68
478	do	J. F. Monroe, Upland	28.21
497	do	T. P. Drinkwater, Corona	29 88
498	do	W. A. Johnstone, San Dimas	27.07
530	do	S. H. Barrett, East Highlands	28.53
	Guaranteed		*26.20*
	Armour Fertilizer Works, Los Angeles, Cal.		
428	Armour's Dried Blood	W. T. Henderson, Riverside	52.02
429	do	Manufacturers, Colton	51.80
454	do	Redlands Fruit Ass'n, Redlands	51.25
	Guaranteed		*48.10*
499	Armour's Acidulated Bone Meal	F. L. Palmer, North Pomona	25.17
	Guaranteed		*24.90*
430*	Armour's Bone Meal	Manufacturers, Colton	31.99
518*	do	H. P. Greene, San Diego	30.35
	Guaranteed		*26.24*
455*	Armour's Bone Meal	Redlands Fruit Ass'n, Redlands	31.54
479*	do	J. Hudson, Highgrove	32.98
541*	do	L. S. Taylor, San Dimas	29.84
	Guaranteed		*27.73*
411	Armour's Bone, Blood, and Potash	Hanson & Catto, Upland	31.47
431	do	W. T. Henderson, Riverside	33.16
520	do	H. P. Greene, San Diego	33.93
	Guaranteed		*33.40*
432	Armour's Bone, Blood, and Potash	Manufacturers, Colton	31.42
456	do	Redlands Fruit Ass'n, Redlands	34.08
	Guaranteed		*32.95*
480	Armour's Bone, Blood, and Potash	J. C. Boyd, Rialto	32.55
	Guaranteed		*33.25*

*430—60 per cent fine.
*518—62 per cent fine.
*455—58 per cent fine.
*479—69 per cent fine.
*541—69 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
424	8.90	1.89	10.79	All samples of complete fertilizers of this company, bone and acid phosphate.	3.22	0.12	0.80	All samples of this company Bl, Bn, T, Bat G, Fs	4.14	------	1.91	------	
425	8.77	1.58	10.35		2.68	0.35	0.90		3.93	------	1.89	------	
495	**7.06**	3.59	10.65		1.88	0.25	1.90		4.03	------	1.70	------	
496	9.15	1.38	10.53		3.48	------	0.79		4.27	------	1.72	------	
515	9.32	1.96	11.28		3.09	0.13	0.96		4.18	------	2.08	------	
516	9.34	1.26	10.60		2.77	0.18	1.12		4.07	------	1.99	------	
517	8.74	1.93	10.67		3.33	0.09	0.72		4.14	------	1.76	------	
527	9.27	1.29	10.56		2.86	0.28	1.07		4.21	------	1.93	------	
528	9.30	1.37	10.67		2.72	0.44	1.12		4.28	------	2.05	------	
529	9.71	1.44	11.15		2.68	0.41	1.17		4.26	------	1.99	------	
547	9.33	1.57	10.90		2.93	0.21	0.91		4.05	------	1.72	------	
----	*9.00*	*1.00*	*10.00*		*2.50*	*0.30*	*1.30*		*4.10*	------	*1.50*	------	
426	8.78	1.71	10.49		2.85	------	0.81		3.66	------	3.20	------	
427	9.77	1.29	11.06		3.09	------	0.81		3.90	------	3.49	------	0 70
478	8.98	1.28	10.26		3.00	------	0.88		3.88	------	3.11	------	
497	10.06	1.54	11.60		3.42	------	0.65		4.07	------	2.84	------	
498	7.38	2.78	10.16		2.96	------	0.90		3.86	------	3.18	------	
530	8.97	1.67	10.64		3.02	------	0.85		3.87	------	3.26	------	
----	*8.00*	*1.00*	*9.00*		*2.75*	------	*0.95*		*3.70*	------	*3.00*	------	
428	------	------	------	------	------	------	14.06	------	14.06	------	------	------	
429	------	------	------	------	------	------	14.00	------	14.00	------	------	------	
454	------	------	------	------	------	------	13.85	------	13.85	------	------	------	
----	------	------	------	------	------	------	*13.00*	------	*13.00*	------	------	------	
499	**13.49**	5.93	19.42	------	------	------	1.67	------	1.67	------	------	------	
----	*15.00*	*3.00*	*18.00*	------	------	------	*1.50*	------	*1.50*	------	------	------	
430	------	------	22.69	------	------	------	4.08	------	4.08	------	------	------	
518	------	------	22.48	------	------	------	3.59	------	3.59	------	------	------	
----	------	------	*20.00*	------	------	------	*3.00*	------	*3.00*	------	------	------	
455	------	------	23.07	------	------	------	3.90	------	3.90	------	------	------	
479	------	------	23.25	------	------	------	4 02	------	4.02	------	------	------	
541	------	------	**22.71**	------	------	------	3.22	------	3.22	------	------	------	
----	------	------	*24.00*	------	------	------	*2.50*	------	*2.50*	------	------	------	
411	7.86	1.72	9.58	------	0.80	------	3.04	------	3.84	------	**6.33**	------	0 78
431	8.38	2.02	10.40	------	0.60	0.20	3.18	------	3.98	------	6.62	------	0.86
520	8.67	1.65	10.32	------	------	------	4.06	------	4.06	------	6.74	------	1 30
----	*8.00*	*2.00*	*10.00*	Bn, G, Super	------	------	*4.00*	Bl, Bn, G, T	*4.00*	------	*7.00*	------	
432	7.28	2.11	9.39	------	1.51	------	2.48	------	3.99	------	**6.43**	------	0 66
456	8.11	1.34	9.45	------	1.54	------	2.58	------	4.12	------	7.76	------	0 80
----	*8.00*	*2.00*	*10.00*	Bn, G, Super	*1.50*	------	*2.50*	Bl, Bn, G, T	*4.00*	------	*7.00*	------	
480	9.07	1.26	10.33	------	0.51	------	3.13	------	**3.64**	------	6.74	------	
----	*8.00*	*2.00*	*10.00*	Bn. Super	*0.40*	------	*3.60*	Bl, Bn, T	*4.00*	------	*7.00*	------	

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Armour Fertilizer Works, Los Angeles, Cal.		
457	Concentrated Superphosphate	Redlands Fruit Ass'n, Redlands	$54.08
	Guaranteed		*51.60*
521	Armour's Flower and Fern Food	W. H. Brown, Los Angeles	32.06
	Guaranteed		*31.72*
458	Armour's Fruit Special	Redlands Fruit Ass'n, Redlands	23.87
500	do	F. L. Palmer, North Pomona	23.41
	Guaranteed		*22.00*
459	Armour's Fruit and Vine Fertilizer	Redlands Fruit Ass'n, Redlands	27.37
519	do	H. P. Greene, San Diego	26.83
	Guaranteed		*27.40*
522	Armour's Lawn and Garden Fertilizer	W. H. Brown, Los Angeles	29.97
	Guaranteed		*24.50*
433	Armour's Orange Tree Manure	Manufacturers, Colton	28.90
434	do	W. T. Henderson, Riverside	27.14
481	do	J. C. Boyd, Rialto	30.40
482	do	J. C. Boyd, Rialto	27.02
	Guaranteed		*26.20*
460	Armour's Orange Tree Manure	Redlands Fruit Ass'n, Redlands	29.13
483	do	G. W. Russell, Ontario	26.81
	Guaranteed		*25.75*
435	Armour's Pea Special	W. T. Henderson, Riverside	23.93
461	do	Redlands Fruit Ass'n, Redlands	24.74
501	do	F. L. Palmer, North Pomona	25.61
	Guaranteed		*25.10*
463	Armour's Special 5-8-2	I. W. Freeman, Redlands	28.32
484	do	J. C. Boyd, Rialto	27.75
532	do	I. W. Freeman, Redlands	29.83
	Guaranteed		*27.40*
531	Armour's Special 5-8-2	I. W. Freeman, Redlands	26.89
	Guaranteed		*26.80*
462	Armour's Sulfate of Potash	Redlands Fruit Ass'n, Redlands	58.66
	Guaranteed		*59.16*
485	Armour's Sulfate of Potash	J. Hudson, Highgrove	**58.56**
	Guaranteed		*60.00*
549	Armour's Sulfate of Potash	Arlington H'ghts Fruit Co., Riverside	**57.17**
	Guaranteed		*58.80*
464*	Royal Knight Special	Redlands Fruit Ass'n, Redlands	32.20
	Guaranteed		*31.40*
502	Armour's Special Fertilizer	F. L. Palmer, North Pomona	32.94
	Guaranteed		*31.10*

*464—87 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds Per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
457	45.07	0.48	45.55										
	43.00	*1.00*	*44.00*										
521	8.32	1.12	9.44		2.12		3.08		5.20		2.86		
	8.00	*2.00*	*10.00*	Bn. G, Super	*1.60*		*3.40*	Bl, Bn, G, T	*5.00*		*3.00*		
458	8.70	2.30	11.00				1.70		1.70		5.13		
500	8.49	1.12	9.61				1.92		1.92		4.79		
	8.00	*2.00*	*10.00*	Bn, Super			*1.50*	Bl, Bn, T	*1.50*		*5.00*		
459	5.97	2.17	8.14				1.94		1.94		10.11		0.86
519	6.29	1.49	7.78				2.07		2.07		**9.25**		0.64
	6.00	*2.00*	*8.00*	Bn, Super			*2.00*	Bl, Bn, T	*2.00*		*10.00*		
522	4.15	0.61	4.76		0.92	0.55	3.95		5.42		4.54		0.66
	4.00	*1.00*	*5.00*	Bn. G, Super			*4.00*	Bl, Bn, G, T	*4.00*		*4.00*		
433	9.00	2.60	11.60				2.95		2.95		5.15		0.76
434	7.99	2.73	10.72				3.19		3.19		3.92		0.64
481	11.83	0.91	12.74				3.13		3.13		3.73		
482	9.41	1.37	10.78				2.92		2.92		3.78		0.72
	8.00	*2.00*	*10.00*	Bn. Super			*3.00*	Bl, Bn, T	*3.00*		*4.00*		
461	8.54	1.95	10.49		1.03	0.23	2.09		3.35		5.13		
483	8.49	0.89	9.38		1.57		1.65		3.22		4.21		0.80
	8.00	*2.00*	*10.00*	Bn, Super	*1.50*		*1.50*	Bl, Bn, T	*3.00*		*4.00*		
435	9.02	4.71	13.73				2.04		**2.04**		2.84		
461	8.41	6.44	14.85				2.29		2.29		2.66		
501	10.97	3.83	14.80				2.11		**2.11**		2.45		
	8.00	*7.00*	*15.00*	Bn. G. Super			*2.50*	Bl, Bn, G, T	*2.50*		*2.50*		
463	7.58	2.55	10.13				4.19		4.19		2.39		0.70
484	8.74	0.93	9.67				3.95		3.95		2.14		0.82
532	8.21	2.65	10.86				4.40		4.40		2.35		0.62
	8.00	*2.00*	*10.00*	Bn. G. Super			*4.00*	Bl, Bn, G, T	*4.00*		*2.00*		
531	7.78	1.95	9.73		2.03		1.98		4.01		2.30		
	8.00	*2.00*	*10.00*	Bn. Super	*2.00*		*2.00*	Bl, Bn, T	*4.00*		*2.00*		
462											48.88		1.88
											49.30		
485											**48.80**		1.36
											50.00		
549											**47.64**		2.86
											49.00		
464			15.54				2.79		2.79		**7.43**		0.52
			15.00	Bn			*2.50*	Bn	*2.50*		*8.00*		
502	8.47	1.00	9.47				5.08		5.08		3.32		
	7.00	*1.00*	*8.00*	Bn, Super			*5.00*	Bl, Bn, T	*5.00*		*3.50*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Armour Fertilizer Works, Los Angeles, Cal.		
533	Armour's Special Fertilizer	John Sharpe, Highgrove	**35.02**
542	do	John Sharpe, Highgrove	**35.63**
	Guaranteed		*44.00*
436*	Armour's Tankage	Manufacturers, Colton	32.15
	Guaranteed		*32.49*
465*	Tankage	Redlands Fruit Ass'n, Redlands	31.80
	Guaranteed		*29.66*
437*	Armour's Tankage	W. T. Henderson, Riverside	30.30
486*	do	J. C. Boyd, Rialto	29.56
	Guaranteed		*28.97*
548*	Armour's Tankage	Arlington H'ghts Fruit Co., Riverside	33.98
	Guaranteed		*32.04*
	California Fertilizer Works, San Francisco, Cal.		
438	Fruit, Orange, and Vine Fertilizer	A. G. Schultz, Porterville	31.77
545	do	C. H. Wente, Livermore	29.00
	Guaranteed		*26.20*
546	Fruit and Vine Fertilizer	Jas. J. Stanfield, Campbell	30.88
	Guaranteed		*26.73*
439	Special Fertilizer	A. G. Schultz, Porterville	25.64
	Guaranteed		*23.20*
	Cudahy Packing Company, South Omaha, Neb.		
550	Cudahy's Blood and Bone	Arlington H'ghts Fruit Co., Riverside	28.48
	Guaranteed		*28.30*
	Thomas Lewis, Sacramento.		
412*	The Lewis Fertilizer	D. D. Allison, Fresno	**4.81**
	Guaranteed		*11.46*
	Maier Fertilizer Co., Los Angeles, Cal.		
523	"A A"	Manufacturers	32.85
534	do	Levi Bemis, Rialto	33.87
	Guaranteed		*31.30*
440	"T"	G. H. Wheeler, Bloomington	26.50
441	do	G. W. Dickson, Riverside	27.10
524	do	Manufacturers	25.01
535	do	Levi Bemis, Rialto	26.35
	Guaranteed		*22.62*
	Mapes Formula and P. G. Co., New York.		
442	Mapes Fruit and Vine Manure	J. J. Prendergast, Redlands	28.29
	Guaranteed		*24.58*

*436—72 per cent fine. *465—74 per cent fine. *437—64 per cent fine.
*486—71 per cent fine. *548—84 per cent fine.
*412—This sample is from goods bought under last year's registration.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred. Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrate	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
533			**11.37**		1.38		5.78		**7.16**				
542			**10.33**		1.44		6.14		**7.58**				
			14.00	Bn, T	*1.00*		*8.00*	Bl, Bn, T	*9.00*				
436			3.85				8.56		**8.56**				1.00
			2.50				*9.00*		*9.00*				
465			3.65				8.47		8.47				
			3.00				*8.00*		*8.00*				
437			15.36				5.31		5.31				
486			14.34				5.20		5.20				
			15.00				*5.00*		*5.00*				
548			12.61				6.66		6.66				
			11.00				*6.50*		*6.50*				
438	8.75	2.82	11.57	Bone-Superphosphate.	0.69	0.68	1.45	Blood, Bone, Tankage.	2.82		8.26		1.04
545	7.16	3.29	10.45		0.56	0.77	1.48		2.81		7.35		0.80
	6.00	*3.50*	*9.50*		*0.50*		*2.00*		*2.50*		*7.00*		
546	8.84	3.97	12.81		0.73	0.90	1.72		3.35		**5.38***		
	6.50	*3.00*	*9.50*		*0.50*		*2.00*		*2.50*		*7.15*		
439	6.24	2.09	8.33				1.03		1.03		**11.16**		0 92
	5.00	*2.00*	*7.00*				*0.50*		*0.50*		*12.00*		
550	**5.89**	7.55	13.44				5.07		5.07				0 92
	7.00	*5.00*	*12.00*				*5.00*		*5.00*				
412	1.19	0.66	1.85						**0.76**		0.33		
	0.15	*2.60*	*2.75*				*2.80*		*2.80*		*0.15*		
523	6.90	6.03	12.93	Bone and Tankage.			5.48	Blood, Bone, Tankage.	5.48		1.54		0.52
534	7.23	5.49	12.72				5.76		5.76		**1.43**		
	7.00	*5.00*	*12.00*				*5.00*		*5.00*		*2.00*		
440	8.32	8.04	16.36				3.75		3.75				
441	10.43	5.98	16.41				3.47		3.47				0.74
524	7.41	6.81	14.22				3.81		3.81				
535	7.72	6.01	13.73				4.22		4.22				
	8.00	*6.00*	*14.00*				*3.00*		*3.00*				
442	5.18	2.25	7.43		0.98	0.50	0.63		2.11		11.37		1.66
	5.00	*2.00*	*7.00*	Bn, G	*1.20*	*0.15*	*0.30*	Bn, G	*1.65*		*10.00*		

*546—This is a farmer's sample taken from only four bags.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Mapes Formula and P. G. Co., New York.		
443	Mapes Orange Tree Manure	J. J. Prendergast, Redlands	$24.53
	Guaranteed		*22.92*
	Nelson, Morris & Co., Chicago, Ill.		
551*	Tankage	Arlington H'ghts Fruit Co., Riverside	33.77
	Guaranteed		*35.01*
	Pacific Bone, Coal, and Fertilizer Co., San Francisco, Cal.		
538	"EE"	Eggers Vineyard Co., San Francisco	32.91
	Guaranteed		*26.78*
544*	Thomas Phosphate Powder	P. C. Rossi, San Francisco	15.99
	Guaranteed		*15.64*
	Southern California Fertilizer Co., Ontario, Cal.		
492	Acid Bone	Mrs. H. N. McKinley, Cucamonga	**29.77**
	Guaranteed		*33.14*
503	Lawn and Nursery	Manufacturers	30.24
	Guaranteed		*28.70*
504	Lawn Special	Manufacturers	26.96
	Guaranteed		*26.26*
467	Orange	J. F. Burdick, Rialto	28.87
	Guaranteed		*25.22*
505	Orange Special	Manufacturers	32.91
	Guaranteed		*30.50*
506	Orange and Lemon	Manufacturers	29.61
	Guaranteed		*27.86*
507	Special Fertilizer	Manufacturers	35.08
	Guaranteed		*35.32*
	Swift & Co., Chicago.		
468	Ground Dried Blood	M. S. Ratliff, Colton	51.28
	Guaranteed		*48.84*
470	Special Acidulated Bone	M. S. Ratliff, Colton	27.69
	Guaranteed		*25.55*
471*	Diamond C	C. B. Smith, Redlands	31.88
	Guaranteed		*29.30*
445*	Diamond E	E. L. Koethen, Riverside	31.57
	Guaranteed		*32.86*
472*	Diamond E	C. B. Smith, Redlands	32.82
	Guaranteed		*34.10*

*551—88 per cent fine.
*544—80 per cent fine.
*471—70 per cent fine.
*445—74 per cent fine.
*472—90 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds Per Hundred.													
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
443	6.06	3.10	9.16		2.00	0.63	0.69		3.32		3.63		1.42
	6.00	*2.00*	*8.00*	Bn, G	*2.40*	*0.15*	*0.74*	Bn, G	*3.29*		*3.00*		
551			14.14				6.11		**6.11**				
			14.00				*6.50*		*6.50*				
538	10.16	3.25	13.41		1.01	1.16	1.44		3.61		5.33		
	6.00	*6.00*	*12.00*	Bn, Super	*0.75*	*0.75*	*1.50*	Bl, Bn, T	*3.00*		*5.00*		
544			17.38										
			17.00										
492	**11.87**	11.62	23.49	Samples of this Company Bone, Tankage, Superphosphate.			2.70	Samples of this Company Blood, Bone, Tankage.	2.70				
	16.00	*7.00*	*23.00*				*2.90*		*2.90*				
503	8.18	1.44	9.62		1.81		3.23		5.04		1.76		0.88
	8.00	*1.00*	*9.00*		*2.00*		*3.00*		*5.00*		*1.00*		
504	3.63	1.58	5.21		0.72		4.77		5.49		1.89		0.74
	3.40	*0.80*	*4.20*		*0.60*		*5.00*		*5.60*		*1.50*		
467	9.86	1.43	11.29		1.12		2.63		3.75		2.62		0.84
	9.00	*1.00*	*10.00*		*1.20*		*2.10*		*3.30*		*2.00*		
505	9.49	3.14	12.63		1.66		2.90		4.56		3.36		0.68
	10.00	*1.00*	*11.00*		*1.20*		*2.90*		*4.10*		*3.00*		
506	8.52	2.25	10.77		1.35		2.72		4.07		3.34		0.74
	9.00	*1.00*	*10.00*		*1.20*		*2.50*		*3.70*		*3.00*		
507					4.80		5.20		10.00				
					4.20		*5.80*	Bl. only.	*10.00*				
468							13.86		13.86				
							13.20		*13.20*				
470	17.10	4.62	21.72				1.35		1.35				
	18.00	*2.00*	*20.00*				*0.82*		*0.82*				
471			28.92				2.26		2.26				
			25.00	Bone			*2.47*	Bone	*2.47*				
445			**17.84**				4.85		4.85				0.56
			19.00	Bone			*4.94*	Bl, Bn, T	*4.94*				
472			18.35				4.74		4.74				
			19.00	Bone			*4.94*	Bl, Bn, T	*4.94*				

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Swift & Co., Chicago.		
487*	Diamond E	O. H. Stanton, North Cucamonga	$33.32
	Guaranteed		*33.63*
446*	Diamond G	E. L. Koethen, Riverside	32.30
473*	do	M. S. Ratliff, Colton	35.61
525*	do	O. H. Stanton, North Cucamonga	**28.94**
	Guaranteed		*33.52*
444*	Special Bone Meal	E. L. Koethen, Riverside	30.29
469*	do	M. S. Ratliff, Colton	30.34
	Guaranteed		*26.15*
	Union Fertilizer Company, Los Angeles, Cal.		
447*	Bone Meal	E. E. Cole, Redlands	24.37
536*	do	J. F. Jackson, Riverside	25.60
	Guaranteed		*24.00*
448	Fruiting Fertilizer	E. E. Cole, Redlands	25.34
449	do	J. B. Hanna, Colton	28.70
474	do	N. L. May, Rialto	26.70
488	do	J. W. Freeman, Upland	24.00
508	do	H. N. Pierce, Claremont	25.19
	Guaranteed		*24.18*
450	Special Fruiting Fertilizer	E. E. Cole, Redlands	34.06
489	do	J. W. Freeman, Upland	31.76
	Guaranteed		*29.50*
	Western Meat Company, San Francisco, Cal.		
451*	W. M. Co. Tankage	Manufacturers	**36.50**
	Guaranteed		*39.70*
	Woodbridge Chemical Works, San Bernardino, Cal.		
475	Woodbridge Citrus A	Manufacturers	31.28
	Guaranteed		*27.70*
453	Woodbridge Citrus B	Manufacturers	24.23
	Guaranteed		*21.10*
476	Woodbridge Special Potato Fertilizer	Manufacturers	38.19
	Guaranteed		*27.40*
477*	The Woodbridge Fertilizer	Manufacturers	33.97
	Guaranteed		*28.94*
493	The Woodbridge Fertilizer	J. H. Williams, Porterville	23.13
	Guaranteed		*21.70*
494	The Woodbridge Fertilizer	J. H. Williams, Porterville	27.20
	Guaranteed		*25.00*
537	The Woodbridge Special Fertilizer	Manufacturers	33.11
	Guaranteed		*25.95*
543	The Woodbridge Special Fertilizer	W. O. Roise, Colton	21.98
	Guaranteed		*19.80*

*487—84 per cent fine. *446—80 per cent fine. *473—74 per cent fine. *525—91 per cent fine. *444—55 per cent fine. *469—60 per cent fine. *447—24 per cent fine *536—27 per cent fine. *451—77 per cent fine. *477—[illegible]

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
487			**17.61**				5.20		5.20				
			19.00	Bone			*4.94*	Bl, Bn, T	*4.94*				
446			**17.97**				3.48		3.48		**4.07**		
473			18.37				4.06		4.06		5.23		3 70
525			**13.09**				3.55		3.55		**3.84**		1.48
			19.00	Bone			*3.25*	Bl, Bn, T	*3.25*		*5.00*		
444			32.16				1.31		1.31				
469			32.28				1.18		1.18				
			29.00				*0.82*		*0.82*				
447			**19.09**				3.35		3.35				
536			**19.34**				3.70		3.70				
			22.00				*2.50*		*2.50*				
448	7.61	0.82	8.43		0.44	0.78	1.61		2.83		4.79		1.70
449	9.35	2.30	11.65		0.63	1.21	1.55		3.39		3.59		0 86
474	8.26	1.45	9.71		0.45	0.91	1.69		3.05		4.34		1.42
488	8.56	0.96	9.52		0.25	0.84	1.49		**2.58**		3.36		0.94
508	7.40	0.98	8.38		0.23	0.65	1.90		2.78		4.90		1 50
	7.00	*2.00*	*9.00*		*0.75*	*0.60*	*1.65*		*3.00*		*3.50*		
450	10.98	1.84	12.82		0.39	1.64	1.85		3.88		5,10		1.46
489	9.89	1.06	10.95		0.50	1.20	2.01		**3.71**		5.13		1 48
	8.00	*2.00*	*10.00*		*1.00*	*0.75*	*2.25*		*4.00*		*4.00*		
451			8.47				8.57		**8.57**				
			8.50				*9.50*		*9.50*				
475	6.10	5.84	11.94				4.46		4.46		4.15		0.58
	5.00	*5.00*	*10.00*	Bn, G, Super			*4.00*	Bl, Bn, G, T	*4.00*		*4.00*		
453	6.47	4.64	11.11				2.63		2.63		3.90		0.54
	5.00	*5.00*	*10.00*	Bn, G			*2.50*	Bl, Bn, G	*2.50*		*3.00*		
476	7.93	3.25	11.18		1.05		3.39		4.44		9.48		0.66
	5.00	*5.00*	*10.00*	Bn, G, Super	*1.00*		*3.00*	Bl, Bn, G	*4.00*		*4.00*		
477			16.23				3.58		3.58		6.48		
			17.00	Bn, G			*2.50*	Bl, Bn, G	*2.50*		*5.00*		
493	4.43	4.67	9.10				2.39		2.39		5.66		
			10.00	Bn, G			*2.00*	Bl, Bn, G	*2.00*		*5.00*		
494	4.45	4.02	**8.47**		1.43		2.13		3.56		6.35		
			10.00	Bn, G	*1.00*		*2.00*	Bl, Bn, G	*3.00*		*5.00*		
537			**13.56**				3.94		3.94		6.18		
			15.00	Bn, G			*2.00*	Bl, Bn, G	*2.00*		*5.00*		
543			10.13				2.59		2.59		3.38		
			10.00	Bn, G Super					*2.00*		*3.00*		

These Samples, Bone, Guano, Tankage, Superphosphate.

These Samples Bone, Guano, Tankage.

SALES OF FERTILIZERS.

According to the statements of fertilizer manufacturers and dealers, rendered under requirements of Section 8 of the fertilizer law, there were sold in the State during the year ending June 30, 1905, 10,280 tons of fertilizers of all classes.

STATION PUBLICATIONS AVAILABLE FOR DISTRIBUTION.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1898. Partial Report of Work of Agricultural Experiment Station for the years 1895-96 and 1896-97.
1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-1903.
1904. Twenty-second Report of the Agricultural Experiment Station for 1903-1904.

BULLETINS.

Reprint. Endurance of Drought in Soils of the Arid Region.
No. 128. Nature, Value, and Utilization of Alkali Lands, and Tolerance of Alkali. (Revised and Reprint, 1905.)
131. The Phylloxera of the Vine.
133. Tolerance of Alkali by Various Cultures.
135. The Potato-Worm in California.
137. Pickling Ripe and Green Olives.
138. Citrus Fruit Culture.
139. Orange and Lemon Rot.
140. Lands of the Colorado Delta in Salton Basin, and Supplement.
141. Deciduous Fruits at Paso Robles.
142. Grasshoppers in California.
143. California Peach-Tree Borer.
144. The Peach-Worm.
145. The Red Spider of Citrus Trees.
146. New Methods of Grafting and Budding Vines.
147. Culture Work of the Substations.
148. Resistant Vines and their Hybrids.
149. California Sugar Industry.
150. The Value of Oak Leaves for Forage.
151. Arsenical Insecticides.
152. Fumigation Dosage.
153. Spraying with Distillates.
154. Sulfur Sprays for Red Spider.
155. Directions for Spraying for the Codling-Moth.
156. Fowl Cholera.
157. Commercial Fertilizers.
158. California Olive Oil; its Manufacture.
159. Contribution to the Study of Fermentation.
160. The Hop Aphis.
161. Tuberculosis in Fowls. (Reprint.)
162. Commercial Fertilizers. (Dec. 1, 1904.)
163. Pear Scab.
164. Poultry Feeding and Proprietary Foods. (Reprint.)
165. Asparagus and Asparagus Rust in California.
166. Spraying for Scale Insects.
167. Manufacture of Dry Wines in Hot Countries.
168. Observations on Some Vine Diseases in Sonoma County.
169. Tolerance of the Sugar Beet for Alkali.
170. Studies in Grasshopper Control.
171. Commercial Fertilizers. (June 30, 1905.)
172. Further Experience in Asparagus Rust Control.

CIRCULARS.

No. 1. Texas Fever.
2. Blackleg.
3. Hog Cholera.
4. Anthrax.
5. Contagious Abortion in Cows.
7. Remedies for Insects.
9. Asparagus Rust.
10. Reading Course in Economic Entomology.
11. Fumigation Practice.
12. Silk Culture.
13. The Culture of the Sugar Beet.
14. Practical Suggestions for Codling-Moth Control in the Pajaro Valley.
15. Recent Problems in Agriculture. What a University Farm is For.
16. Notes on Seed-Wheat.
17. Why Agriculture Should be Taught in the Public Schools.

Copies may be had by application to the Director of the Experiment Station, Berkeley, California.

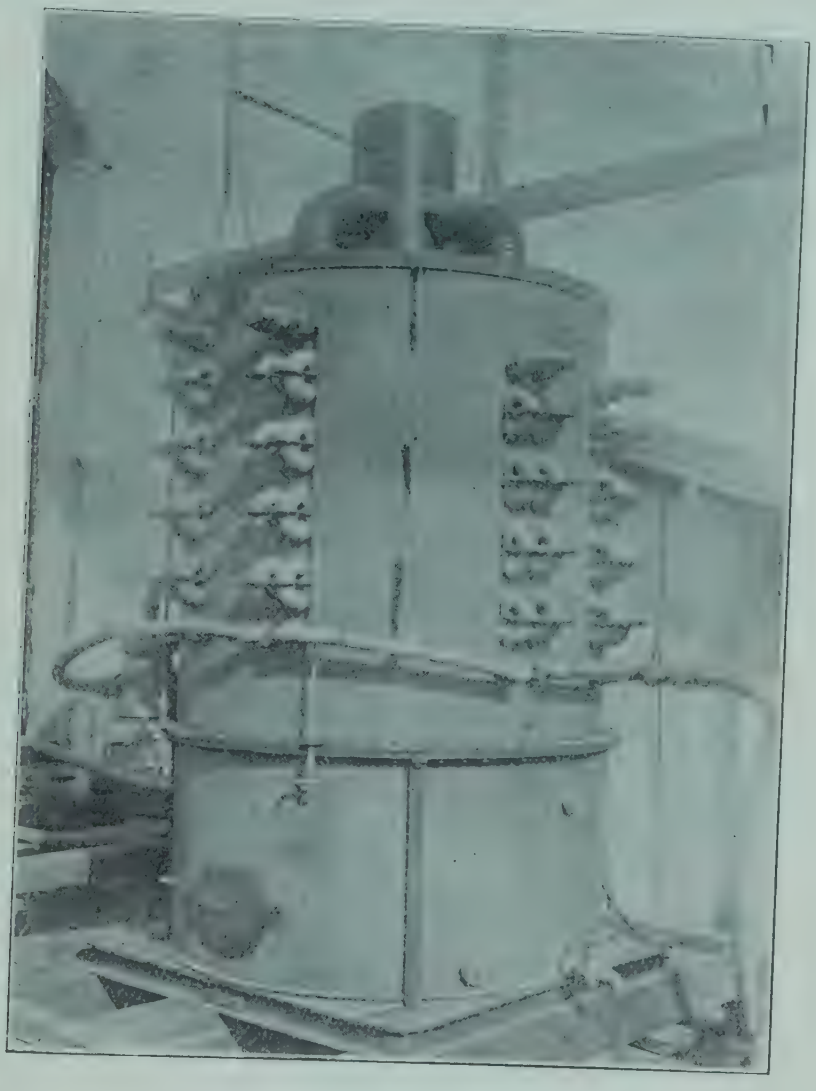
UNIVERSITY OF CALIFORNIA PUBLICATIONS.

COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

A New Method of Making Dry Red Wine.

By FREDERIC T. BIOLETTI.



BULLETIN No. 177.

(Berkeley, Cal., February, 1906.)

SACRAMENTO:

W. W. SHANNON, : : : : SUPERINTENDENT STATE PRINTING.

1906.

BENJAMIN IDE WHEELER, Ph.D., LL.D., *President of the University*

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W. A. SETCHELL, Ph.D., *Botanist.*
ELWOOD MEAD, M.S., C.E., *Irrigation Engineer.*
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R. H. LOUGHRIDGE, Ph.D., *Agricultural Geologist and Soil Physicist.* (*Soils and Alkali.*)
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G. W. SHAW, M.A., Ph.D., *Assistant Chemist.* (*Cereals, Oils, Beet-Sugar.*)
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RALPH E. SMITH, B.S., *Plant Pathologist.*
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ALBERT M. WEST, B.S., *Assistant Plant Pathologist.*
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G. R. STEWART, *Student Assistant in Station Laboratory.*
ALICE R. THOMPSON, B.S., *Assistant in Soil Laboratory.*
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VINCENT J. HUNTLEY, *Foreman of California Poultry Experiment Station*, Petaluma.

The Station publications (REPORTS AND BULLETINS), *so long as available, will be sent to any citizen of the State on application.*

A NEW METHOD OF MAKING DRY RED WINE.

In Bulletin No. 167 of this Station, discussing various means of improving the quality of dry wines made in hot countries, the conclusion was reached that the method which offered the best hope of attaining the end in view was that by which the requisite tannin and color were extracted by heat before fermentation. The method, as outlined there, is as follows:

"1. Heating the crushed grapes to a temperature and for a time sufficient to extract the necessary color, tannin, and body.

"2. Immediate separation of the must, and cooling to 85° F.

"3. Immediate fermentation of the must at a temperature not exceeding 90° F."

The bulletin further states: "The present status of the method is this:

"1. It has been shown, both in California and in France, that it is possible, when working with small quantities, to attain the object in view by this method.

"2. The method has been used with success in France in the whole output of a cellar manufacturing 75,000 gallons of wine in a season."

Experiments, made on a sufficiently large scale during the past vintage, have further demonstrated that the method is perfectly adapted to large-scale practice in California, and that it is possible by this means to produce a wine of excellent quality where it had been found impracticable to do so by the old methods. These experiments indicate strongly, moreover, that it is not only possible to make good dry red wine by this means, but that, where the climate is hot during the vintage, it is the simplest and most economical method of attaining the end in view when working on a large industrial scale.

This is not intended to mean that the use of this method alone is all that is necessary to improve the quality of the dry wines of our hotter regions, but that, together with proper attention to the ordinary details of wine-making, the proper use of cooling machines, and perhaps of pure yeast, we have a means by which we can be sure every year of making the best wine that the grapes available are capable of producing. In a cellar properly arranged for the purpose, all this can be accomplished at a cost so little in excess of the cost of the usual methods of manufacture that the loss which occurs in practically every large

winery in the State, of a few vats of wine by bad or incomplete fermentation, far more than counterbalances it.

The experiments show further that, where the grapes are well ripened and in fair condition, all that is necessary in our hot valleys, for the production of good, sound wine, is the use of cooling devices in the fermentation, and attention to proper sterilization of vats and casks.

In order to give a clearer idea of how the method could be carried out on a large scale in a winery built for the purpose, a plan of such a winery has been given with enough detail to exemplify all parts of the process and to enable any one to calculate the cost of operation.

While the main object of the experiments was to test the capabilities of the method referred to, other methods and other matters of interest in the fermentation of wine were investigated both for comparison and for the purpose of devising the best way of carrying out the method in practice.

The main lines of investigation were the following:

1. Extraction of color and tannin by artificial heating.
2. Control of the temperature of fermentation by means of a cooling machine.
3. The use of pure and selected yeast.
4. The use of sulfurous acid in controlling the temperature of fermenting grapes.
5. The making of wine from incompletely ripe grapes.

In order to make the bearing of the experiments clear, a detailed account of the method used is necessary. Reference to pages 19 to 26 of Bulletin No. 167 will make the objects of the principal experiment clear. There, will be found a discussion of the effects of high temperatures on the fermentation of wine, and an account of the preliminary laboratory experiments which led to the devising of the method used in the larger winery experiments this year.

It will be seen, from the reference given, that high temperatures have beneficial and necessary, as well as injurious, effects in the production of dry red wine, and the experiments detailed in this bulletin show that a practical method has been devised which will "combine the beneficial effects of heat in the extraction of color, tannin, and body with those of cool fermentation in producing bouquet, freshness, and maximum amount of alcohol." These experiments also indicate very strongly that by use of the method recommended we are certain to produce a sound wine from any grapes in fair condition, however hot the season; and that, even when the grapes are inferior by reason of mold, drying up, etc., much better wine can be made than by any of the usual methods.

The principal merit of the method, therefore, is the *certainty* it gives that *every vat* of wine will be *perfectly sound every year.*

DESCRIPTION OF METHOD.

Crushing.—The grapes were taken as they came to the winery in the usual way, passed through the ordinary crusher and stemmer, and pumped by means of a must-pump through the regular must-line into 1,500-gallon vats.

As the crushed grapes came into the vat a small amount of potassium meta-bisulfite dissolved in water was added gradually, in such a way as to distribute it equally throughout the vat. The amount used varied from .2 to .4 per mil. of the weight of the grapes, that is to say, from 6 to 12 ounces per ton.

The sulfite was added to paralyze temporarily the action of the molds, bacteria, and yeast present, and to facilitate the solution of the color. Another important use of the sulfite is to prevent too much oxidation during the heating, and so to avoid the "rancido" taste which might be acquired if the grapes were allowed to remain hot too long or if they were heated too high.

Preparation of Vats.—The vats were cleaned with hot water and soda and then swabbed with a 3% solution of commercial sulfuric acid to partially disinfect them. The acid solution was left on the walls of the vats for a few hours and then rinsed off with water.

Straining.—At the bottom of each vat was placed a strainer extending from the bunghole across the whole bottom to the opposite side. The form of strainer used is shown in Fig. 1. It consisted of an

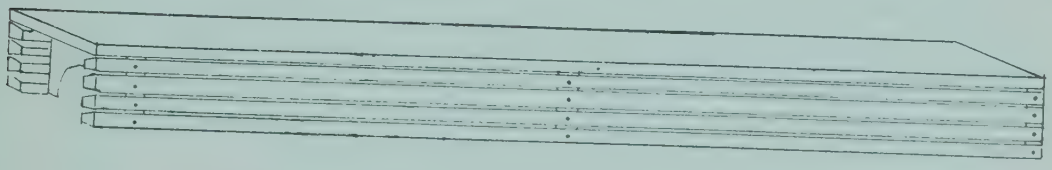


FIG. 1. Strainer for bottom of Fermenting Vat.

inverted rectangular trough closed at one end and having a top consisting of a solid board, and sides consisting of slats made with beveled edges like the slats of a press basket.

These strainers were found to be not sufficiently effective, owing to the very thorough way in which the grapes were broken up by the method of handling. In practice it would be necessary to have a more efficient method of straining, or to adopt a method of crushing the grapes and conveying them to the vats, which would not result in such complete maceration.

The former, *i. e.*, the use of a more efficient straining device, would be preferable, as it is very desirable to have the grape-pulp thoroughly disintegrated in order to facilitate the extraction, which takes place the more rapidly the more completely the grapes are crushed.

As soon as the vat was full of crushed grapes the must was allowed to run off the skins into another vat. It was found possible to run off a volume of must equal to only one half of the total volume of the crushed grapes. With a better arrangement for straining, a volume equal to two-thirds could be run off, which would much facilitate the subsequent operations.

Heating.—As soon as the must was separated it was passed through the heater and back into the vat containing the strained skins. The must was heated to from 140° to 150° F., and as the grapes were much cooler they remained at the bottom, and it was found very difficult to mix the two when the hot must was pumped on to the top. This difficulty was overcome in great measure by attaching the hose, bringing the must from the heater, to a faucet in the bottom of the vat. By this means the hot must was forced through the cool grapes, and a thorough stirring at the end equalized the temperature in the whole vat.

The Heater.—The must was heated by means of a "must-heater" constructed by Gomot, of Nimes, France. This machine is essentially a large tubular pasteurizer, the exterior of which is shown in the figure on the cover.

The height of the boiler is 6 feet 10 inches from the ground to the top, and the chimney is 2 feet 5 inches more. Its diameter is 4 feet 3½ inches, and the tube connections protrude a few inches more on all sides.

It consists of a system of copper tubes, through which the wine runs, and a boiler surrounding them, which is heated by a fire in the firebox below, from which the heat passes by four flues into the chimney. When used in the way intended by the manufacturer, the boiler is filled with water. In our experiments, acting on the suggestion of Mr. Meakin, we found it more convenient to simply admit steam into the boiler and to dispense with both water and fire.

There are eighty straight copper tubes joined by unions outside the boiler, as shown in the figure. These tubes are each 3 feet 10 inches long and 1½ inches in diameter, and are easily cleaned by removing the couplings, for which purpose the arrangement is very simple. In our experiments, there was no deposit whatever in the tubes, and after passing water through the machine they were found perfectly clean.

The machine is furnished with a strainer, which prevents seeds and skins passing into the tubes. This strainer must be opened and cleaned occasionally, and is so constructed that this is easily done. Four thermometers are placed in various parts of the heater, which enable the operator to control the heating perfectly. There is one thermometer in the boiler, one at the entrance of the must, one at the exit, and one halfway between these. By carefully watching these thermometers and

manipulating the steam valve, the heating can be regulated in a few minutes to any degree required. The heating remains very constant so long as the steam pressure does not vary, and providing the supply of must is regular.

A hand pump can not be used to supply the must, as the output is too irregular. It is necessary to have a pump that will give a constant stream of uniform volume. For this purpose a steam pump would be excellent, as its output can be regulated to any desired rate. For the experiments a gasoline motor pump especially constructed by Gomot for the purpose was used. The rate of pumping could be varied by a

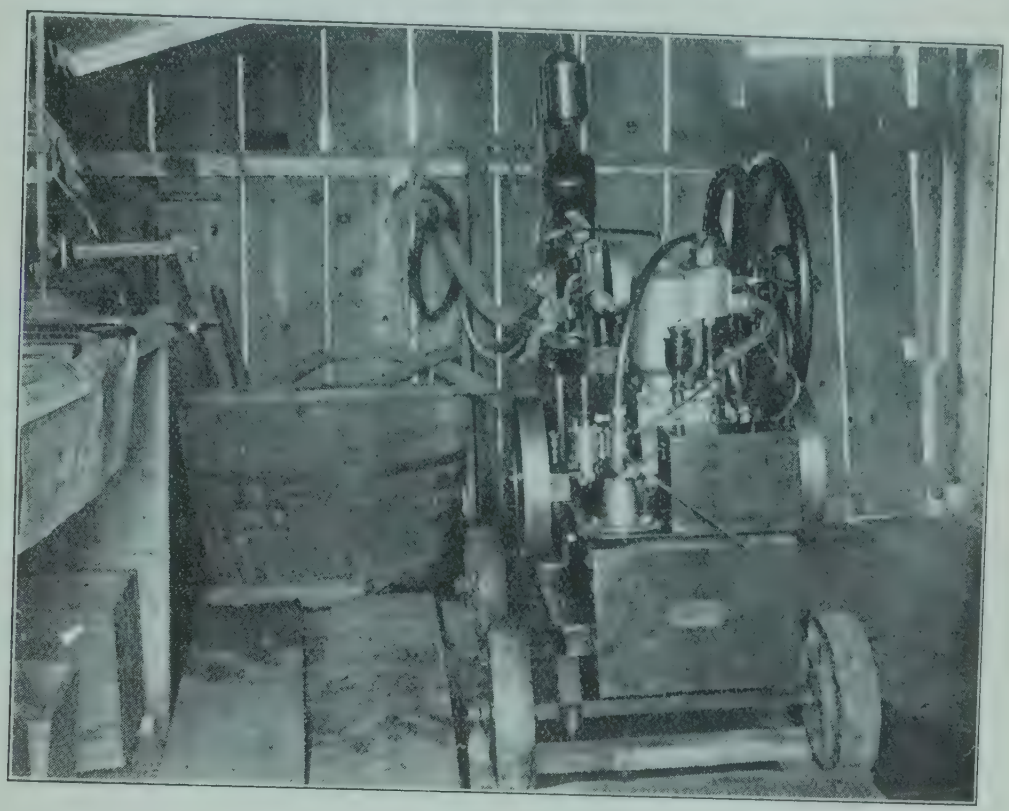


FIG. 2. Gomot Motor Pump.

simple arrangement to from 375 to 1,500 gallons per hour. Such control of the rate of pumping is necessary, as the heating depends on the rate with which the must passes through the machine, as well as upon the amount and pressure of the steam admitted.

Capacity of Heater.—It was found that the machine would heat 1,000 gallons of must per hour from 75° to 150° F. when the temperature of the boiler was kept at 185° F. The steam pressure during the trials was 80 pounds. There was no pressure in the boiler of the heater, as it has an opening above.

Heating the must to 150° F. is about what would be found convenient in practice if the temperature of the crushed grapes was 75° F. and two-

thirds of their volume of must was passed through the heater at 150° F. This is just about what is necessary to give the desired results.

Extraction.—When the mass of crushed grapes has reached the desired temperature, it is left, with occasional stirrings (every three or four hours), until the required color and tannin have been extracted by the must.

It has been shown by the experiments detailed on page 22 of Bulletin No. 167 that the color and tannin are extracted *pari passu*, so that by periodical observations of the color it is possible to note the progress of extraction.

Salleron's Vino-Colorimeter.—For this purpose a Salleron vino-colorimeter is extremely useful. A very full description of the nature and use of this instrument was given by Prof. E. W. Hilgard in the Viti-

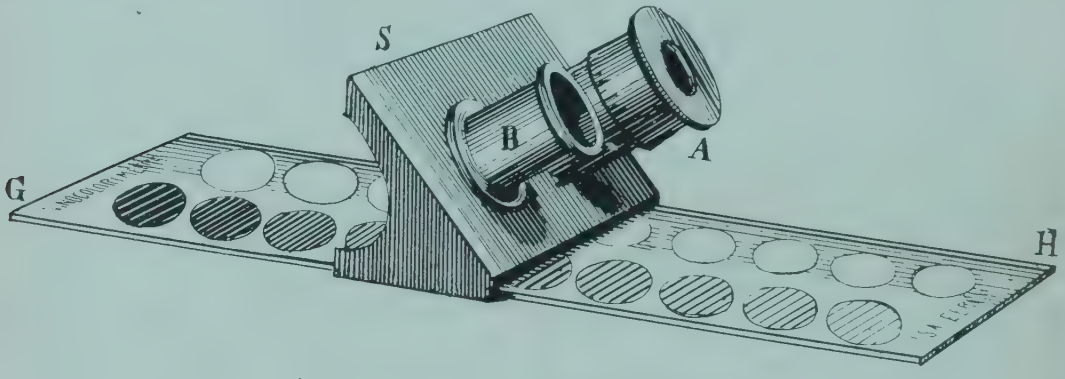


FIG. 3. Salleron's Vino-Colorimeter.

cultural Report for the seasons 1885 and 1886, on pages 23 and 26. So far, this is the best and most practical means which has come into general use for measuring the color of wine, and as some quick and reliable means of determining the color during the process of extraction is necessary for the proper carrying out of this method, a short description of the instrument is given here.

The colors of wines differ in two respects. They may differ in tint (that is to say, the kind or nature of the color may differ), and they may differ in intensity (that is, the depth or amount of color may differ). In order, therefore, to measure the color of a wine and to compare it with the color of another wine we must measure both its tint and its intensity. Both these measurements may be made with the Salleron vino-colorimeter.

For the determination of the tint a scale (Fig. 3, G–H) is furnished, consisting of a piece of cardboard on which are gummed small disks of silk which represent all the tints usually found in dry red wines. At the top of the scale is a disk marked VR (violet-red), which is the tint of a new wine made from a good coloring grape with full acidity, such as the Petite Sirah or Cabernet. At the bottom of the scale is a disk

marked 3R (third red), which is the tint of an inferior coloring grape with low acidity, such as Grenache or Mission. Between these extremes are eight other disks representing the intermediate tints which red wines may have. Altogether there are ten disks representing ten tints, which are marked as indicated in Fig. 4. Each tint differs from the one above it in having a slightly greater admixture of yellow.

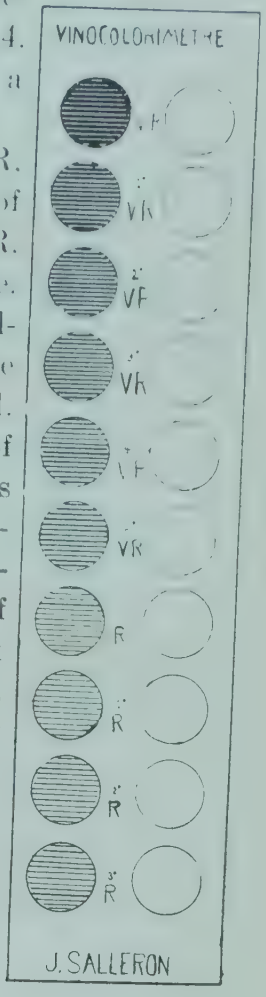
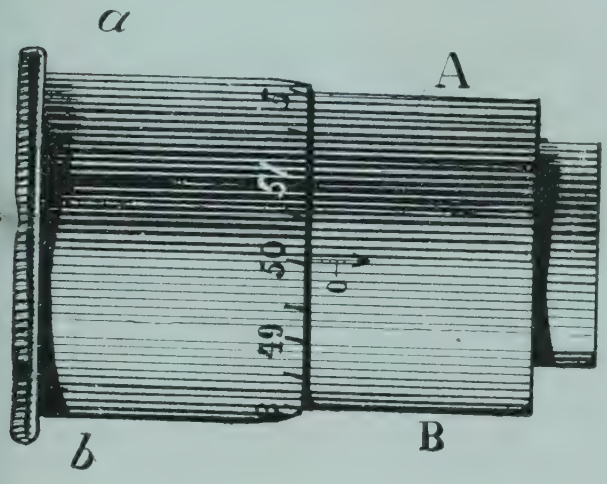


FIG. 4.
Scale of Tints.

Wines of claret type should not fall below the 5VR, while those of Burgundy type may go to the bottom of the scale. Ports contain more yellow even than the 3R, and can not be measured satisfactorily by this scale. As wines become older the tint gradually becomes yellower, so that a wine which when made corresponds to the VR disk may fall to the 5VR disk when it is a year old.

All the disks are made with the same intensity of color, so that in order to compare wines with them it is necessary to reduce the intensity of color of the wines to that of the disks. This is done by varying the thickness of wine through which we look. If we observe the color of a wine by looking through it in a glass three inches in diameter it will appear to be twice as dark or intense as if we look through it in a glass of only one and one-half inches diameter. This principle is made use of, both to bring the wine to the standard intensity which makes it possible to compare its tint, and also to measure the intensity itself.



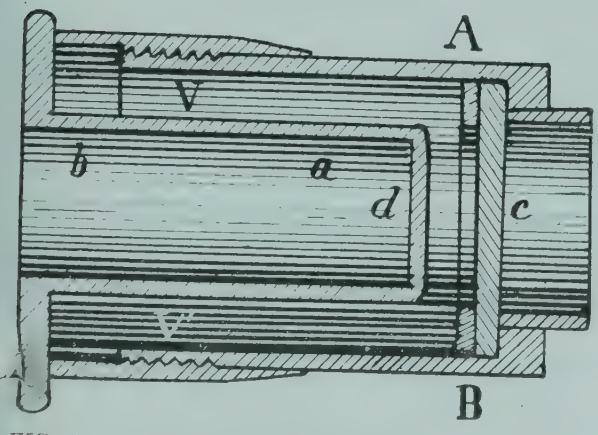


FIG. 5. Construction of Salleron's Vino-Colorimeter.

To use the instrument a small portion of the wine is placed in the receptacle V (Fig. 5), and the screw cap *ab* moved up or down until the thickness of wine between the glass

disks *c* and *d* through which we look gives us an intensity equal to that of the disks. The scale is then moved back and forth until the proper tint is found.

We now have all the data for describing the exact color of the wine. The tint is given by the name of the disk used and the intensity by the distance of *d* from *c*, which is read off from the scale on the outside of the cap *ab* at the point marked on AB with an arrow.

If we get such a reading as 3VR, 160 it means that the *tint* of the wine is third violet red and the *standard intensity* is obtained by looking through 160 hundredths of a millimeter of the wine. If we get the reading 80 on the scale it will show that only half as much wine is necessary to give the standard intensity and, therefore, that the wine is twice as dark or intensely colored as in the first case. The smaller the reading on the scale, therefore, the more deeply colored the wine.

To overcome this inconvenience Professor Hilgard has adopted a scale of which the notation is inversely proportionate to the thickness of the wine necessary to give the standard tint, and of which, therefore, the numbers given are directly proportionate to the intensity of color. For this purpose he has taken a wine which required 40 hundredths of a millimeter to give the standard intensity as an arbitrary standard, which he calls 100. A wine with half this amount of color would then, with this scale, have an intensity of 50. The number is obtained by dividing 4,000 by the reading of the scale. This would give us, then, for the first example an intensity of 4000÷160, or 25, and for the second 4000÷80, or 50.

If R represents the reading on the scale, then $4000 \div R =$ Intensity by Professor Hilgard's scale.

Comparison of Scales.

Salleron Scale.		Hilgard Scale.
40	=	100
80	=	50
160	=	25, etc.

The Hilgard scale has the great advantage of giving a clear idea of the intensity of color in a wine without the need of making any mental calculations, for if the color of one wine is represented by a number three times as large as that representing the color of another we know that the first has three times as much color as the latter.

Professor Hilgard's notation has been used in the account of experiment work detailed later.

In the absence of any recognized standard of intensity for the color of wines it is difficult to say what the proper degree of color is. In order to give some idea of what the numbers of Professor Hilgard's scale indicate in practice, it may be said that a wine measuring 15 in

intensity would be considered sufficiently dark for an ordinary table wine. Any wine which falls below 10 is too light in color, while anything over 20 may be considered darker than is necessary. These figures have reference to the United States. In Europe the popular taste does not require quite so much color.

A young wine should contain more color than these figures indicate, as a certain proportion of the color always drops during aging. This loss of color is most rapid during the first two months after fermentation. It becomes less rapid later, until after four months the loss is very slow. The amount of loss varies very much with different wines, and with different methods of handling, but a Zinfandel to have 15 of color when it is two years old should have at least 35 or 40 directly after drawing off from the fermenting vat, and, to preserve its color even so well as this, it must have full acidity and must not be aged too quickly by frequent racking or keeping in small casks or warm cellars.

The following table is appended to show the actual loss of color found by observation. The tests were made with experiment wines fermented at the Station cellar, and were all made in small quantities and kept in casks of from 10 to 20 gallons. In larger quantities the loss of color would be slower, and the depth of color indicated for four months probably corresponds to what would be found in practice in a wine of the same character at the end of eighteen months or two years:

TABLE I.

Loss of Color during Aging of Wine.

Number of Wines Examined.	Color.								
	At Pressing.	1 Month.		2 Months.		3 Months.		4 Months.	
			Loss.		*Loss.*		*Loss.*		*Loss.*
Four	330	191	42.1%	117	64.5%	114	65.4%	101	69.4%
Six	140	95	32.2%	91	35.0%	68	51.4%	59	56.8%
Five	85	50	41.2%	36	57.6%	34	60.0%	27	68.2%
Seven	35	25	28.6%	16	54.3%	15	57.1%	13	62.9%
Five	23	15	34.8%	11	52.2%	10	56.5%	9	60.9%
Three	13	9	30.7%	9	30.7%	7	46.2%	5	61.5%
Average of color remaining	100		65.1%		50.9%		43.9%		36.5%
Average loss of original color for each month			34.9%		14.2%		7.0%		7.4%

It will be seen by examining the table that approximately the same proportion of the color is lost whatever the original color in the wine, so that it is possible to foretell within very close limits what the color of a wine will be at the end of a certain time when kept under certain conditions. This applies only to wines of which the coloring matter is normal. Wines made from such grapes as Lenoir, Grenache, Trousseau, or from partially dried or moldy grapes, lose their color more quickly.

It may be said, then, that wines kept in very small casks lose about one-third of their color during the first month, about one-half during the first two months, and nearly two-thirds of their color during the first four months after pressing.

The loss at first is much more rapid in the very deeply colored wines than in those more lightly colored, as is shown by the curves in Fig. 6.

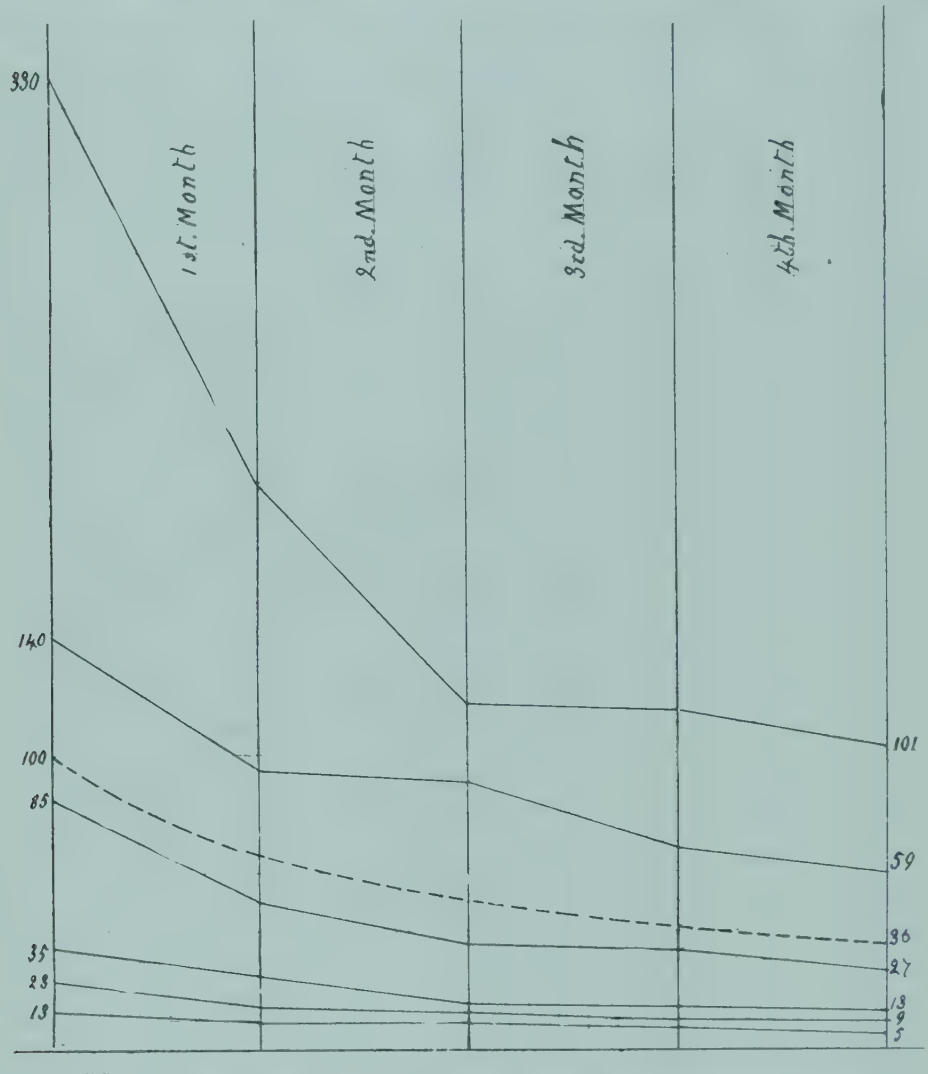


FIG. 6. Loss of Color in Red Wines during the First Four Months.

The numbers on the right show the color at pressing; those on the left at four months. The dotted curve shows the average loss calculated from observations on thirty wines.

Cooling.—As soon as the extraction of the skins has proceeded far enough, as indicated by the reading of the colorimeter, the must, now containing tannin and color, is drawn off and cooled to 80° or 85° F. This was done in the experiments by means of the cooling machine described in Bulletin No. 174. As the must is hot (125° F.) and the temperature has to be lowered only to 80° or 85° F., the cooling takes place very easily and rapidly with the cooler used. The hot must runs off very freely, as the pulp cells of the grapes have all been thoroughly

heated and have lost the power of retaining the juice possessed by the cells of fresh grapes. A certain amount of juice remains, however, in the skin, most of which can be recovered by pressing, as is ordinarily done with fermented grapes. It would be better to extract this juice by some diffusion process, but so far no satisfactory method of doing this has been devised. In the experiments, only the must which ran off without pressing was used, but it would be very desirable to obtain that remaining in the skins, as it contains more color than that in the free run. A continuous press would be excellent for this purpose, as the maceration of the pomace which occurs with such presses would not have the bad effect it has when pressing fermented pomace, because the extra amount of solid matter would be to a great extent precipitated during fermentation.

As soon as the must is cooled and run into fermenting vats, any correction which it needs, such as the addition of acid or water, should be made. At the same time a starter of yeast should be used, preferably of tested pure yeast.

Pure Yeast.—In the experiments, a pure Champagne yeast was used. This yeast had been thoroughly tested and found capable of fermenting out very sweet musts and producing a good wine. The same yeast was used in all the experiments and was found to give good results with both white and red wines.

Method of Using the Pure Yeast.—A method was devised for keeping a supply of pure yeast on hand for the various fermentations, which was found very simple and convenient. As the method is of general application and could be used for the same purpose with the ordinary methods of wine-making, it is described here.

The method adopted was as follows: Starting with a 4-ounce flask, the pure yeast was increased by pouring it into a large flask containing one gallon of must which had just been cooled to 90° F. after sterilizing by boiling. Three days later, this gallon of must was fermenting well and contained a large amount of active yeast. In the meanwhile 25 gallons of must, obtained from clean, sound grapes, had been cleared of its sediment and yeast by settling with sulfurous acid. This was done by adding 1 ounce of potassium meta-bisulfite dissolved in one pint of water to 25 gallons of must. This had the effect of preventing fermentation until all sediment, including the molds and yeast, in the must had settled. In twenty-four hours, must treated in this way was perfectly bright and was racked off into a clean cask which had been thoroughly sterilized by steaming. Must treated in this way is practically free from all fermentative organisms. Five gallons of this clear must were then freed from the sulfurous acid by boiling and placed in a shallow tub which had been thoroughly cleaned and sterilized with

boiling water. As soon as the must in the tub had cooled to 90° F., the gallon of yeast in the flask was added and the whole thoroughly aërated by dipping up the must with a gallon measure and pouring it through the air back into the tub. As soon as fermentation was well under way (twenty-four hours), 2½ gallons of the clear must were added without previous boiling. More than this should not be added for fear of the arrest of the fermentation which might occur if too much of the must containing sulfite were added at once. The next day, 5 gallons more of the clear sulfited-must were added. It was safe to add more this time as the yeast was becoming used to the sulfurous acid. Twenty-four hours later the remaining 12½ gallons of the sulfited-must were added.

In this way, at the end of six days, 25 gallons of must containing pure yeast were obtained practically free from molds, bacteria, or wild yeast. In order to have a maximum amount of vigorous yeast in the must it should be thoroughly aërated several times every day, and fermented in a low, wide tub.

As soon as a stock of pure yeast is obtained in this way it can be kept up simply by replacing the yeast taken out with an equal quantity of clear sulfited-must prepared in the way described. During the vintage it is not necessary to crush and press grapes specially for this purpose, but the must can be taken directly from the vats or casks, care being taken to sulfite the must as soon as it is separated from the grapes, before the slightest fermentation has commenced.

A stock of 25 gallons is sufficient for the fermentation of 2,000 gallons per day. Twenty gallons may be taken from the pure yeast tub every day and replaced with sulfited-must, and if the temperature is kept above 80° F. and the must is not too sweet (not over 22% B.) and sufficient aëration is given, the amount of yeast in the must will not diminish.

Every care should be given to prevent contamination of the yeast. The yeast tub should be kept covered with a clean cloth and should be placed in a room separate from the fermenting vats. All tubs, buckets, casks, hose, etc., used in the production of the yeast should be thoroughly sterilized with boiling water and not used for other purposes.

While it is not pretended that by these means, however carefully carried out, we are sure to obtain an absolutely pure culture of yeast, in the sense that it does not contain a single germ or cell of anything but the yeast we start with, it was found that, for practical purposes, it preserves the culture pure during the whole vintage. As we add the yeast to grapes containing spores and germs of many kinds or to imperfectly sterilized must, the few contaminating spores that may get into our pure yeast are quite harmless. This is true, however, only if we exercise well the precautions indicated. If we allow vinegar flies to get at our yeast vats, or draw off the yeast with hoses used for racking wine or must, the yeast will quickly become badly contaminated.

Fermentation.—After the red must has been cooled and the yeast added, fermentation will start immediately. Within twenty-four hours the temperature will rise to 90° or 95° F., depending on the outside temperature and the size of the vat. Before it reaches 95° F. the fermenting must is passed through the cooler and reduced to 80° F. If the weather is not very hot, the vats do not contain more than from 1,000 to 3,000 gallons, and the original density of the must does not exceed 22% to 23% Balling, this cooling will be sufficient. Usually, however, if we are to have a cool fermentation, another cooling later will be necessary. In the experiments two coolings were always given, and wines containing over 14% of alcohol and in one case over 15% fermented out perfectly dry.

After Fermentation.—With musts containing no more than 22% Balling, it is possible to obtain perfectly dry wines in four to five days in the fermenting vats. To insure this, a certain amount of aëration should be given at each cooling. This is accomplished simply by allowing the stream of cooled must to fall through the air a distance of three or four feet into the vat. The must will in this way carry down enough air to keep the yeast working vigorously. This aëration will at the same time get rid of any excess of sulfurous acid which may be present. In the experiment wines, this was accomplished so perfectly that only the faintest traces of the acid were found in the finished wines, an amount less than one-fiftieth of that allowed in French wines imported into the United States.

More aëration than is necessary for the completion of the fermentation should be avoided, on account of its effect on the color, which is diminished in quantity and injured in quality by excessive exposure to the oxygen of the air.

With musts containing over 24% Balling it will usually be found impossible to ferment the wine perfectly dry in the four days, but it is inadvisable to leave it in the open fermenting vats any longer than this. At the end of four days, whatever the strength of the original must, the fermentation will be very slow. If the temperature, however, has never exceeded 95° F. it will not have ceased entirely, and every effort should be made to keep it going until the wine is perfectly dry. It is a capital mistake to allow the fermentation to stop and the yeast to settle while the wine still contains .5%, 1%, or even 2% of sugar, as is often done in the hope that the fermentation will recommence in the spring and eliminate this sugar.

At the end of four days in the open vat the wine should be transferred to a storage cask however much sugar it still contains. This transfer should be made with thorough aëration, and the receiving cask should not be sulfured. The wine should run in a stream which falls

through the air into the pump-tub, or well, and should enter the storage cask through the upper bunghole so that it will fall through the air in the cask, unless some other means is adopted for supplying the needed oxygen.

This aëration will reinvigorate the yeast and will usually be sufficient to keep the fermentation going until the wine is dry. The wine should be watched, however, and, if in seven days it is not dry, it should be aërated again by running it off from the bottom of the cask and pumping it back into the same cask. In the experiments this was found sufficient, even in cases where the resulting wine showed over 15% of alcohol, to bring the wine to dryness in three weeks from the time the grapes were crushed.

By this means the dangerous bacterial fermentations, which so often injure wines, even when they do not spoil them, during the one or two months following the vintage, will be avoided. The presence of a small quantity of sugar in the wine can not be detected by means of the ordinary saccharometer or mustimeter used by cellermen. The saccharometer may descend to the 0 mark, or even considerably below in wines which contain over 1% of sugar. This is especially true of highly alcoholic wines, which are the most troublesome to get dry. The taste of the wine-maker is the only practical means of determining the presence of a dangerous residue of sugar in the wine.

So long as a taste of sweetness can be perceived in the wine by a practiced taster, means should be adopted to keep the fermentation going. For this purpose, usually all that is necessary is an occasional aëration and stirring up of the yeast, as already described. Prompt action, however, is necessary. The wine should never be allowed to get cold before it is quite dry. If the wine is placed in puncheons or other small casks it is very useful, if not quite necessary, to keep it in a room where the temperature does not fall below 70° F. If it is placed in large casks (1,000 to 5,000 gallons or larger), it will retain its heat for a sufficient time to become perfectly dry if the needed aëration is given.

If, even with these measures properly carried out, the wine still remains sweet, it means, provided the grapes used were not excessively moldy, that the original must contained more sugar than it is possible for the yeast to eliminate. If the must contains more than 28% Balling, as will sometimes happen, especially when partially dried grapes are present, there is usually no possibility of fermenting it dry. In this case, the sugar may be eliminated by blending with a wine containing less than 12% of alcohol. This blending, however, must be done promptly, before either wine has become cold and before the wine containing sugar has become injured by bacterial fermentation. If a wine is not perfectly dry within seven days after being transferred from the fermenting vat to the storage cask, an alcohol determination should be

made. If there is more than a mere trace of sugar and the alcohol exceeds 14½%, the wine should be blended immediately with a weaker wine and aërated again.

First Racking.—While, so long as any sugar remains, our efforts should be directed toward keeping the yeast vigorous and suspended in the wine, we should use means to accomplish the opposite results as soon as the sugar has all disappeared and the wine is perfectly dry.

The function of the yeast is to change the sugar of the must into the alcohol of the wine. As soon as this is effected the wine should be freed from the yeast as soon as possible. If the fermentation has been conducted successfully, the yeast will commence to deposit immediately and the wine will be comparatively clear within two or three weeks after it has become dry. The first racking, then, should take place at this time and, as there is no need for further fermentation, the casks into which the wine is racked should be sulfured. This should be done with both red and white wines. The sulfur will remove a little of the color in the former case, but some of this will return as the sulfurous acid disappears, and the color remaining will be much more stable. Properly sulfured red wines will show more color at the end of six months than similar wines which have not been sulfured.

It is neither necessary nor advisable to wait until the wine is perfectly clear before making the first racking. All wines made by commercial methods contain a few bacteria and many of them a great many, and even when wines taste dry there is often a trace of sugar left which is sufficient to serve as nourishment for the bacteria. It is very desirable, therefore, to put the wine in such a condition that the bacteria will be deposited and the wine cleared as soon as possible. This is accomplished by racking without aëration, which eliminates the yeast and bacteria in the thick lees, and by sulfuring and cooling, which stop the action of the floating bacteria and cause them to be deposited.

After the first racking, or before, if the wine is perfectly dry to the taste, the cellar should be kept as cool as possible and the wine protected as much as possible from the air, in order to promote the settling of all the fine lees and hasten the perfect clearing of the wine.

EXPERIMENTS: RED WINE.

I. *Over-ripe Grapes; Extraction by Heat; Use of Cooler; Pure Yeast.*—On August 21st, at 3 P. M., about twelve tons of Zinfandel grapes were passed through the crusher and stemmer and pumped by means of a must pump into a vat furnished with a strainer. The grapes were very ripe, with a large proportion of shriveled berries, and some quite dry. There were abundant signs of Mildew (Oidium) and some Black Mold (Aspergillus). The must showed 26% Balling and .55% of acid

immediately after crushing and before the sugar from the dried grapes had diffused out into the must. There was a very little second crop present.

Before placing the grapes in the vats, the latter were thoroughly washed and then swabbed with a 3% solution of sulfuric acid, which was left on the wood for several hours and then rinsed off with water. This treatment was given to all the vats used in the experiments.

As soon as the vat was full, the must was drawn off and passed through the Gomot heater, from which it passed with a temperature of 140° F. back on to the skins in the original vat. This was continued with occasional stirring of the grapes until the contents of the vat had reached a temperature of 112° F. Before passing the must through the heater, 3.75 pounds of potassium meta-bisulfite were added to it to prevent the oxidizing effect of the air on the heated grapes.

At 7 A. M. of the next day, August 22d, the must in the vat was red, but not deeply colored. The color was 2VR, 49.4. (See page 10.) The must at this time showed 27% Balling, owing to the diffusion of the sugar from the dried grapes into the must. The acid was .65% and the tannin .32%. The tannin was sufficiently high, but in order to increase the color it was decided to heat the vat again.

At 9 A. M. the must was drawn off again and passed through the heater at 150° to 158° F. and back on to the skins until the whole vat showed 133° F.

At 10 A. M. the color had increased to 2VR, 65.6, and the tannin to .352%.

At 4 P. M. of the same day the red must was run through the cooler, reduced in temperature to 84° F., and a starter of 15 gallons of Champagne yeast (see p. 13) added. Later, 250 gallons of water and 5 pounds of citric acid were added to the 1,700 gallons of must.

The progress of the fermentation is shown below:

		Sugar.	Temperature.
Aug. 22,	6:00 P. M.	27% B.	84° F.
Aug. 23,	6:00 A. M., fermenting well	25	85
	12:00 M., water and acid added.		
	1:00 P. M.	22	84
	Color, 3VR, 58; Acid, .66%; Tannin, .35%.		
	5:00 P. M., passed through cooler	19	90
	7:00 P. M.	19	84
Aug. 24,	7:00 A. M., cooled to 84° F.	16	92
	Color, 1VR, 41.2.		
	12:00 M.	13½	87
	5:00 P. M.	12	89
Aug. 25,	7:00 A. M., cooled to 90°	7	96
	Color, 3VR, 27.5.		
	12:00 M.	5.2	90
	6:00 P. M.	4.5	89
Aug. 26,	6:00 A. M.	2.5	93
	12:00 M.	1.5	93
	Racked into storage vat.		
Aug. 27,	Nearly dry.		

On September 1st the wine showed 13.5% of alcohol and the color was 4VR, 26.3. On September 7th it was nearly clear, and was racked into puncheons, and in a few days was quite dry and clear.

This experiment shows that heating the grapes to 112° F. is not sufficient to extract the maximum amount of color of ripe Zinfandel, even though the grapes are kept hot for fifteen hours.

The fermenting wine was cooled three times. This was necessary because the regular cooling machine was not ready for use and a temporary and less efficient device had to be used. The fermenting wine was lowered 20° F. by the three coolings. This could have been done, as was proved later, by one cooling of two hours at the rate of 750 gallons per hour with the form of cooling machine finally adopted, or by two coolings of one hour at the same rate. The effect on the fermentation, however, was the same, and it continued without interruption until the wine was dry at six days, with 13.5% of alcohol. It is instructive to compare this result with Experiment III, where the cooling was intentionally less complete. The wine of Experiment III required thirty days to become dry, though the alcohol in the wine was 1% less than in the wine of this experiment.

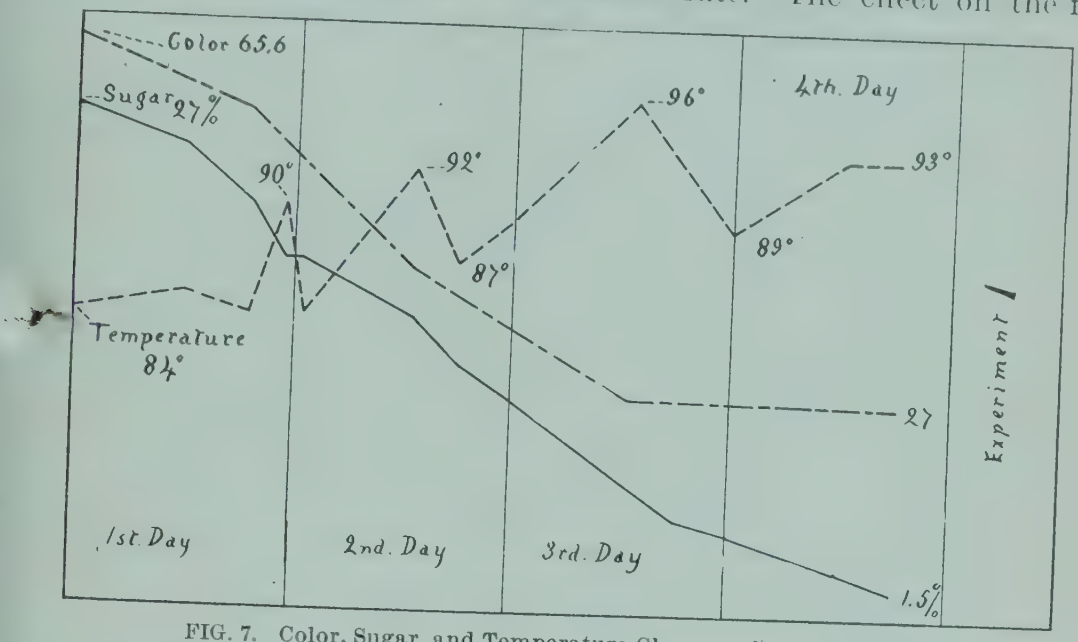


FIG. 7. Color, Sugar, and Temperature Changes of Experiment I.

An examination of Fig. 7 shows that the curve representing the diminution of color during fermentation is for the first three days very nearly parallel to that representing the diminution of the sugar-content. This probably indicates that the part of the color insoluble in alcohol is deposited in the same ratio as the alcohol is produced by the fermentation of the sugar. This rapid fall of the color ceases on the fourth day, the color which remains at this time being soluble in alcohol, and the further production of alcohol has little or no effect on it. The number 27 representing the color at the end of the fourth day probably

indicates the whole amount of the original color in the grapes which is capable of remaining dissolved in the fermented wine. Whether all of this could have been extracted by the ordinary methods of fermentation is not shown by the experiment, but a comparison with the results of Experiment III indicates that it could not. The wine of the latter experiment, made from grapes similar to those used in Experiment I, had only 18 of color at the end of the fermentation. With regard to the stability of the color the comparison is even more strikingly in favor of the new method. At the end of three months the color of the wine of Experiment I was practically the same as when the fermentation had finished at four days, while the wine of Experiment III had lost 28% of its color.

The broken line in Fig. 7 shows the temperature changes observed during the fermentation. A drop in temperature occurred four times. The first, a slight drop, was due to the addition of cold water used to dilute the must. The other three drops are the effects of the coolings which were given when the fermenting wine reached 90°, 92°, and 96°, respectively. A point of interest in this curve is that the abrupt changes in temperature had practically no effect on the rapidity of fermentation, as is shown by the even curve representing the disappearance of sugar. A slight irregularity of the sugar curve may be noticed opposite each jog representing a cooling on the temperature curve, but the irregularity is so slight that it is of no practical importance. This is shown equally in Experiment IX (see Fig. 10, page 25), where coolings of 13° F. and 14° F. show hardly any appreciable effect on the rate of fermentation. This lack of apparent influence of the cooling on the rate of fermentation is probably due to the fact that each cooling was accompanied by an aëration which invigorated the yeast and counteracted the retarding effect of the lower temperature.

II. *Under-ripe Grapes; Use of Cooler; Pure Yeast.*—On August 25th about twelve tons of Zinfandel grapes were crushed, stemmed, and pumped into a fermenting vat, a starter of pure Champagne yeast being added as the grapes came into the vat. The grapes were poorly colored and not thoroughly mature. They showed 22.7% Balling and .66% of acid. The record of the fermentation is as follows:

	Sugar.	Temperature.
Aug. 25, 10:00 A. M.	22.7° B.	71° F.
7:00 P. M.	22.2	74
Aug. 26, 7:00 A. M., fermenting well	22.4	78
12:00 M., fermenting well	20.4	78
7:00 P. M., fermenting well	19.2	88
Aug. 27, 7:00 A. M., cooled to 90° F.	6.0	96
12:00 M.	5.5	90
7:00 P. M.	4.0	92
Aug. 28, 7:00 A. M., racked into storage vat	1.0	94

Aug. 29, Dry.

Sept. 7, The wine was still cloudy, but was racked into puncheons.

This experiment illustrates the fact that even when the grapes are gathered incompletely mature, the temperature of the fermentation must be controlled in a hot climate if we are to produce a dry wine; and it also shows that we can not expect to produce wine of good quality from unripe grapes, as will be seen by comparing the quality of the various experiment wines as given on page 27.

The checking of the fermentation at the time of cooling is more perceptible in this fermentation than in any of the others. In this case, as in that of the last cooling in Experiment IX, the checking at cooling is probably merely a coincidence and due in reality to the large amount of alcohol present at that stage of the fermentation. The upward course of the temperature curve (Fig. 8) during the first day without

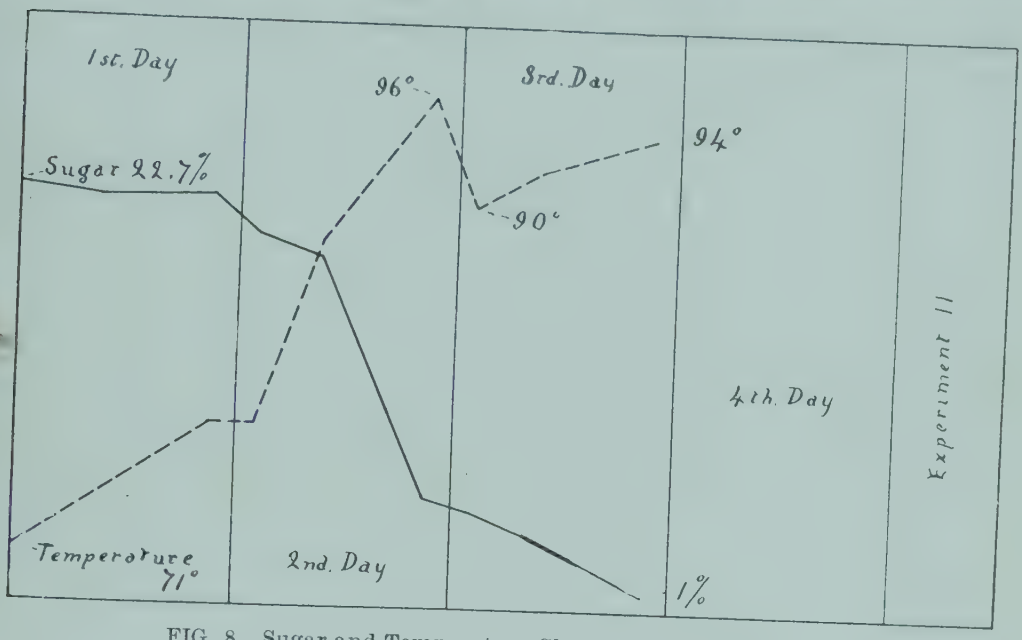


FIG. 8. Sugar and Temperature Changes of Experiment II

any corresponding decrease of sugar is due undoubtedly simply to errors of observation. It is extremely difficult to take an average sample for either sugar or temperature determination in a vat of crushed grapes immediately after filling. Later, after fermentation has commenced and the grapes have been well stirred, the observations are much less liable to error. The average temperature of this vat at the beginning was undoubtedly higher than 71° F. The same peculiarity is seen in the curves of Fig. 9.

III. *Ripe Grapes; Incomplete Cooling; Sulfite; Pure Yeast.* On August 25th about twelve tons of Zinfandel grapes in fair condition, except for a considerable amount of black mold, were crushed, stemmed, and pumped into a fermenting vat. The must showed 23.7% Balling

and .66% of acid. Pure Champagne yeast was added as the grapes came into the vat. The record of fermentation is as follows:

		Sugar.	Temperature.
Aug. 25,	6:00 P. M.	23.7 / B.	74° F.
Aug. 26,	7:00 A. M.	23.2	82
	12:00 M., fermenting well	20.0	85
	6:00 P. M.	16.0	90
Aug. 27,	6:00 A. M.	7.2	96
	12:00 M., cooled to 90° F. and added two pounds sulfite	6.0	98
	6:00 P. M.	6.0	90
Aug. 28,	6:00 A. M., evidently "stuck"	6.0	88
	12:00 M.	5.5	89
	6:00 P. M.	5.0	90
Aug. 29,	6:00 A. M.	5.0	92
	12:00 M.	5.0	92
	6:00 P. M.	4.5	90
Aug. 30,		4.0	92
Aug. 31,	Racked into storage vat	3.0	90

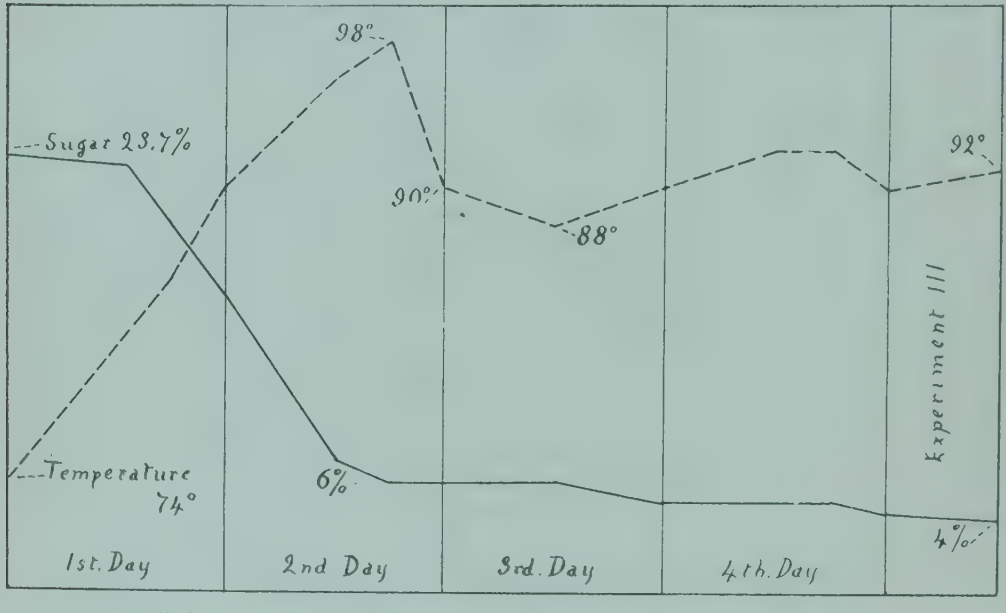


FIG. 9. Sugar and Temperature Changes of Experiment III.

On September 1st the color was 5YR, 18.7, and the wine remained sweet until September 11th, when it was pumped over for an hour. On September 22d it was nearly dry, but still cloudy.

This experiment shows the danger of allowing the fermentation to rise as high as 98° F., but also the possibility of getting it through completely within a few weeks without any serious damage to the quality. In this case the chief loss was the extra trouble and time needed to get the wine dry. The cooling ought to have been done very early on the morning of August 27th instead of waiting until the afternoon. It was a mistake also to add the sulfite at noon on August 27th. The sulfite, if used at all, should have been added on the evening of August 26th, before the high temperature was reached.

The curves of Fig. 9 are instructive in several particulars. Compared with those of Fig. 10 they show plainly that the hottest fermentation

is not necessarily that which finishes first. In Fig. 9 the sugar curve drops very rapidly from the middle of the first day to the middle of the second, when it comes to an abrupt stop, becoming almost horizontal for twenty-four hours. The rapid loss of sugar is accompanied by a corresponding rapid rise in temperature due to the former. The temperature of 98° reached practically stops the fermentation completely for twenty-four hours. This is shown both by the sugar remaining unchanged and by the temperature falling. The wine was cooled from 98° to 90° by the machine, and then instead of rising again, as it would have done if there had been any active fermentation going on and as it did after every cooling in Experiments I and IX (see Figs. 5, 7, and 10), it fell to 88°. This shows that there was not enough fermentation going on to counterbalance the heat lost by radiation. The vat had "stuck." The "sticking," however, was not so serious as it often is in vats which rise higher than 98°, or stay at this temperature for some time. The cooling as soon as the temperature reached 98°, and the aëration practiced afterwards, revived the fermentation, as is shown by the gradual rise of the temperature curve and the fall of the sugar curve.

IV. *Over-ripe Grapes: Dilution; Addition of Acid.*—On September 1st at 11 A. M., five tons of Zinfandel grapes were crushed and stemmed into a fermenting vat. The grapes were over-ripe, some of the berries dried, and there was a large amount of black mold. The must showed 29.5% Balling and .7% acidity. It was diluted with 250 gallons of water, to which was added 6 pounds of tartaric acid.

The temperature of the grapes at the start was 73° F., and within thirty-six hours had risen to 90° F. at the bottom of the vat and 104° F. in the cap. The fermentation stuck when the sugar had fallen to 7% Balling, and could not be revived by cooling. The wine was used for port, as an attempt to make it dry would probably have resulted in spoiling it completely.

This experiment shows the futility of attempting to make a dry wine in a hot climate from over-ripe grapes, even if the acidity is increased artificially and the sugar decreased by dilution, unless we adopt some means of controlling the temperature.

V. *Over-ripe Grapes; Dilution; Addition of Acid; Control of Temperature by Use of Sulfites.*—A vat of Zinfandel grapes, similar in every respect to those used in Experiment IV, was diluted and acidified in exactly the same way and an attempt made to control the temperature by the occasional addition of a calculated amount of a solution of potassium meta-bisulfite. The experiment was a failure, as the temperature ran up to a higher point than that reached in Experiment IV, and the wine stuck with 12% Balling.

This was by no means a conclusive test of the method, as the amount of sulfite used was too small. The use of sulfite was tested again in Experiment VII.

VII. *Ripe Grapes; Pure Yeast; Control of Temperature by Use of Sulfites; Pomace and Must Fermented Separately.*—(Debono method, see Bulletin No. 167, p. 18.) The grapes used in this experiment consisted of 29% Charbono, 29% Lenoir, and 42% Burger; nine tons in all. They were ripe and in good condition, the mixture showing 22.5° Balling. The following is the record of the fermentation:

September 2d, 3:00 P. M. Crushed and added potassium meta-bisulfite solution (=.06 per mil.) and 15 gallons of Champagne yeast accustomed to sulfite.

September 3d, 7:00 A. M. The fermentation had commenced, and the must was drawn off into an open vat and given another dose of sulfite solution twice as large as the first dose (=.12 per mil.). The must and pomace were then allowed to ferment separately.

The further progress of the fermentation is shown by the following table:

	Must.		Pomace.	
	Temp.	Sugar.	Temp.	Sugar.
Sept. 3, 6:00 P. M.	74° F.	22.5% B.	74° F.	22.5% B.
Sept. 4, 7:00 A. M.	86	13	94	6
5:00 P. M.	94	10	98	2.5
Added more sulfite (=.12 per mil.).				
Sept. 5, 7:00 A. M.	96	4.5	100	1.5
12:00 M.	98	2.5	100	1.0

3:00 P. M. The must, which had fallen to 2% Balling, was now pumped back on to the pomace and allowed to stand, after a thorough stirring, for twenty-four hours. When first mixed, the vat showed a temperature of 98° F. and 2% Balling.

Sept. 6, 7:00 A. M. Temperature 92° F., sugar 1.5% Balling.

12:00 M. Racked off pomace into open vat and aërated. The color of the wine was 2VR, 20.3.

Sept. 7. The wine was transferred to a storage cask.

Sept. 11. The wine still tastes a little sweet and was pumped over for one hour.

Sept. 22. Still shows a slight trace of sweetness.

While this wine did not stick entirely and finally went through perfectly dry, there is no evidence in the experiment that the addition of the sulfite had the slightest effect in preventing high temperatures. The grapes had only 22.5% of sugar and were cool (74° F.) when crushed. If we reckon that each per cent of sugar in fermenting heats the must 1.17° F.,* the temperature of the fermenting grapes should have reached 97.5° F. when 20% of sugar had fermented out. This corresponds almost exactly to what occurred, so that there is no delay of fermentation or moderation of temperature that can be accredited to the sulfite. If sulfites are to be effective for this purpose they must evidently be used in larger doses than those adopted in this experiment.

*See Bulletin No. 174, pp. 17, 18, 19.

IX. *Ripe Grapes; Pure Yeast; Extraction by Heat; Temperature Controlled by Cooling Machine.*—The grapes used in this experiment were a mixture of Grenache 45%, Zinfandel 31½%, and Lenoir 23½%. They were mature and in good condition except for a few dried and moldy grapes and some green bunches of second crop in the Zinfandel. The must was passed through the heater and back on to the pomace until the temperature of the whole was 125° F., and the whole well stirred. This was on the afternoon of September 8th, and at 9 A. M. of September 9th the must was drawn off the pomace and cooled. The

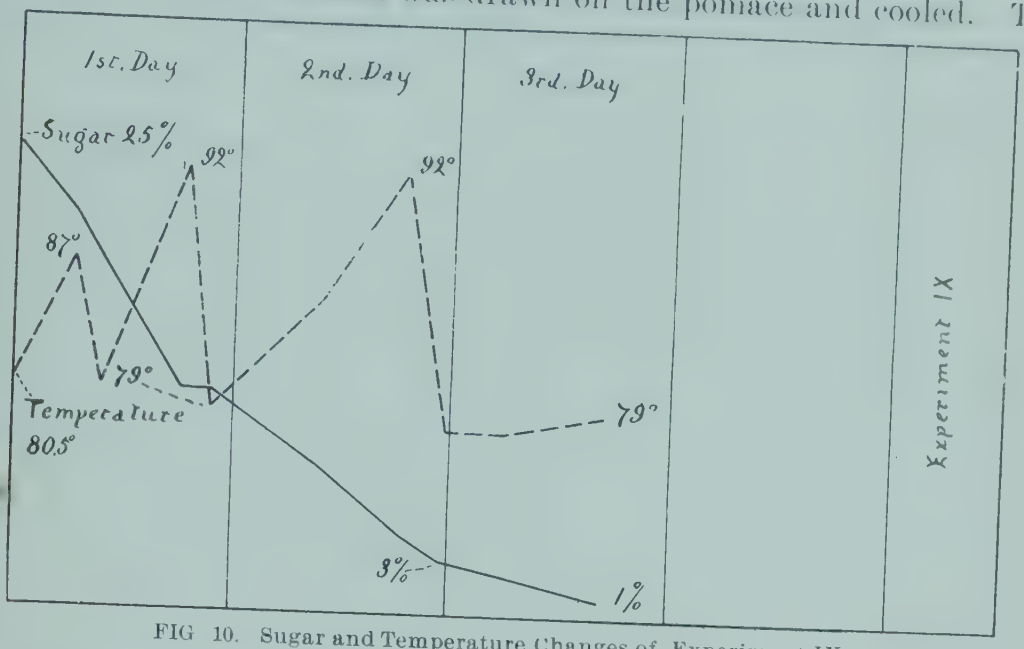


FIG 10. Sugar and Temperature Changes of Experiment IX.

color of the must was 1 VR, 53.4. Yeast was added, and the fermentation proceeded as follows:

		Sugar.	Temperature.
Sept. 9,	4:00 P. M.	23.0% B.	84° F.
	7:00 P. M., cooled to 80°	21.5	87
	10:00 P. M.	19.0	80
Sept. 10,	7:00 A. M., cooled to 79°	12.5	92
	10:00 A. M.	12.0	79
	10:00 P. M.	8.0	85
Sept. 11,	7:00 A. M., cooled to 78°	4.5	92
	12:00 M.	3.0	78
	6:00 P. M.	2.5	78
Sept. 12,	7:00 A. M., transferred to a storage cask	1.0	79
Sept. 19,	Still a little sweet and still fermenting.		
Sept. 23.	Pumped over for one hour.		

This experiment exemplifies the benefit to be derived from complete control of the temperature by efficient cooling. The wine required a month to become quite dry, but at the end of that time all the sugar was eliminated, although the wine contained 15.1% of alcohol. It became dry as soon as did the wine of Experiment III, which contained only 12.5% of alcohol but was allowed to reach a temperature of 98° F. The wine was cooled three times, a total of 27° F. being taken out by the cooler. The same result could have been obtained with considerably

less cooling if in order to avoid night work the first cooling had not been done sooner than was necessary. The last cooling, moreover, was much greater than was necessary and might have been dispensed with altogether.

The sugar curve in Fig. 10 is in marked contrast with that of Fig. 9. The drop in the curve is just as rapid during the first thirty-six hours, but instead of being checked there it continues for forty-eight hours until the sugar reaches 3%. Here the fermentation is checked slightly but not "stuck," and the wine was practically dry in three days when Experiment III still had 5% of sugar. This difference is undoubtedly due altogether to the fact that Experiment IX was not allowed to rise above 92° F.

EXPERIMENTS: WHITE WINE.

VI. *Defecation by Sulfuring; Pure Yeast; Fermentation in Puncheons.*—The grapes used in this experiment were about eight tons of Johannisberg and Franken Riesling. They were in excellent condition and were a striking example of what can be done by proper care and cultivation, even with varieties presumably so unsuited to a hot climate as the grapes of the Rhine. The grapes were thoroughly and evenly matured and showed no sunburn, mildew, or mold.

They were crushed into an open vat, and the first 500 gallons of must which ran off was pumped into a heavily sulfured cask. After settling for twenty-four hours, the must was drawn off into three sulfured puncheons and started with pure Champagne yeast.

The following is the record of the fermentation:

Date.	Sugar.	Temperature.
August 26th	22.5% B.	78° F.
August 27th	16.7	85
August 28th	9.1	88
August 29th	4.7	88
August 30th	2.8	88
August 31st	2.0	87

The wine fermented slowly, and on September 2d was still a little sweet. It was then pumped-over to aërate it, and on September 8th was dry and nearly clear.

VI*a*. *Fermentation Started on Skins; Pure Yeast; Fermentation in Puncheons.*—After drawing 500 gallons of must off the crushed grapes of Experiment VI, the remainder was left on the skins for twelve hours. At the end of this time a slight fermentation was perceptible, and the must was drawn off into sulfured puncheons and started with Champagne yeast. The following is the record of the fermentation:

Date.	Sugar.	Temperature.
August 26th	25.0% B.	78° F.
August 27th	8.7	92
August 28th	5.9	89
August 29th	4.4	87
August 30th	4.0	86
August 31st	4.0	84

The wine was treated in the same way as in Experiment VI, but on September 8th it was still cloudy and slightly sweet. On September 22d it was cloudy and fermenting and had a slight brownish color. It finally became nearly dry about October 21st, and the brownish tint had almost disappeared, though it was still cloudy.

A 50-gallon cask of each experiment wine was shipped to Berkeley and stored in the Station cellar. They were tasted on November 24, 1905, with the following results:

Exp. I. Perfectly clear, full flavor, sound, fruity, and agreeable, but with a slight taste of dried grapes.

Exp. II. Cloudy, of poor color and a little mousey.

Exp. III. Clear and a good wine, but inferior to Experiment I.

Exp. VII. Clear, odor peculiar, flavor good.

Exp. IX. Clear, a little better than Experiment VII.

Exp. VI and VI*a*. Nearly clear, contain a small amount of sugar. Good, full-bodied wines of somewhat Sauterne type.

Exp. VIII. Tastes flat, but otherwise a fair wine of neutral Sauterne type.

Order of merit of the red wines: I, III, IX, VII, II; of the white: VI, VI*a*, VIII.

The analyses of the wines made on December 1, 1905, by Prof. George E. Colby, are given in the following table:

TABLE II.

Analyses of Experiment Wines from Fresno.

December 1, 1905.	Exp. I.	Exp. II.	Exp. III.	Exp. VI	Exp. VI*a*.	Exp. VII.	Exp. IX.	Exp. VIII.
Specific gravity	.9935	.9955	.9970	.9900	.9925	.9980	.9930	.9910
Alcohol, per cent by volatile	13.80	12.30	12.50	13.25	14.50	11.70	15.10	12.60
Alcohol, grams per 100 cc	10.95	9.76	9.92	10.51	11.51	9 29	11.98	10.00
"Extract," grams per 100 cc	3.02	3.10	3.25	2.19	2.80	3.30	2.60	2.07
Ash, grams per 100 cc	.37	.38	.45	.25	.37	.57	.41	.33
Acidity, total, as tartaric; grams per 100 cc	.457	.397	.442	.390	.337	.375	.315	.375
Acidity, fixed, as tartaric; grams per 100 cc	.324	.285	.300	.300	.292	.300	.232	.315
Acidity, volatile, as acetic; grams per 100 cc	.108	.090	.114	.072	.036	.060	.066	.048
Sugar, total, grams per 100 cc	.....	.200	.300	.....	.300	.300	.....	.....
Tannin	.292	.160	.240	.....	.....	.280	.260	.....

A puncheon of each of the experiment wines was kept separate and left at the cellar where they were made. They were tasted on January 1, 1906. The wines made by the new method, I and IX, were bright, dry, clean-tasting, and of good flavor. The wines made in the ordinary way, III and VII, were dry and clean-tasting, clear but not bright. The main differences to be perceived in the wines were that those made by the new method were brighter and more astringent than the others.

The white wines were all in excellent condition, and, on the whole, surprisingly good wines for the district and the conditions in which they were made. The Burger was rather flat and lacking in acid.

COLOR-CHANGES IN THE RED WINES.

The record of the color-changes in the various red wines is shown in the following table. The same record is shown graphically in Fig. 11.

TABLE III.

Color of Experiment Wines.

	Exp. I.	Exp. II.	Exp. III.	Exp. VII.	Exp. IX.
Before fermentation	2VR, 65.6				1VR, 53.4
After fermentation	3VR, 27.5	R, 13.1	5VR, 18.7	2VR, 20.3	22.4
3 months' fermentation		3R+Y, 7.5	5VR, 13.4	2R, 13.0	4VR, 19.6
4½ months' fermentation	3VR, 16.2	3R+Y, 5.3	R, 10.2	1R, 9.7	4VR, 17.0
Loss of color in 3 months		43%	28%	36%	12
Loss of color in 4½ months	41%	60%	45%	52%	24%

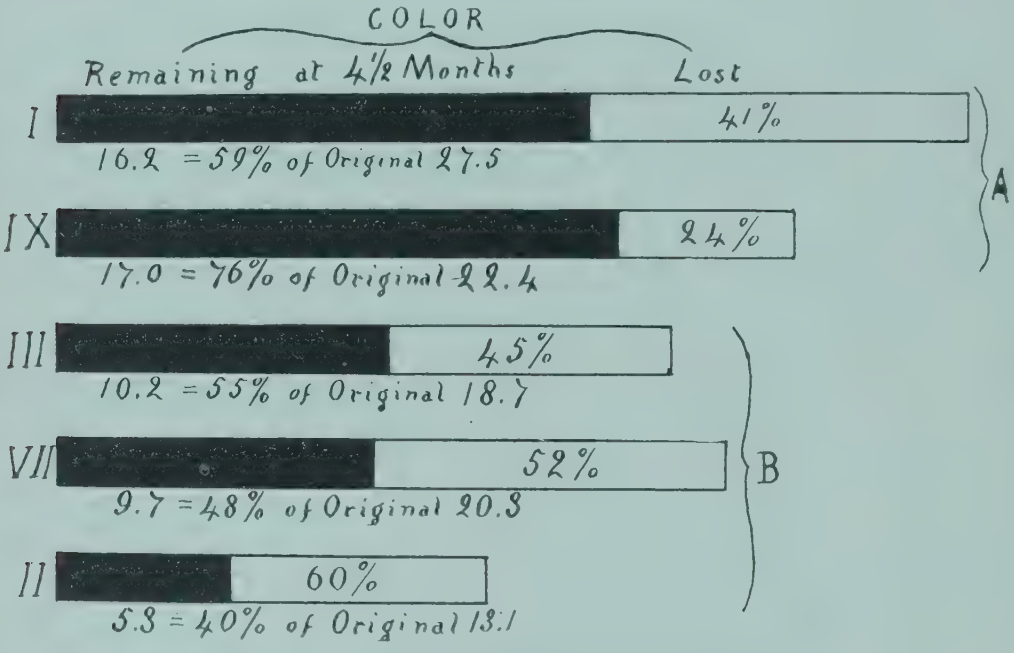


FIG. 11. COLOR OF THE RED EXPERIMENT WINES.

A. Color extracted by heating before fermentation.
B. Color extracted in the ordinary way by fermentation.
Shaded Portion = Color remaining January 15, 1906.
Clear Portion = The amount of the original color lost.
The sum of the above is the amount of color in the wine when it was taken from the fermenting vats to the storage casks.

Figure 11 shows graphically two very important points in favor of the new method: First, the color extracted by heating before fermentation is as high or higher than that obtained by the usual method: and second, that it is more stable. Leaving out the wine of Experiment II, which was made from unripe grapes and was therefore abnormal, we find that the average loss of color of the heated wines in 4½ months was 32.5%, while that of the ordinary wines in the same period was 48.5%. Experiment II was cloudy and of poor quality.

CONCLUSIONS.

The most important conclusion to be drawn from these experiments is that sound dry wine of fair quality can be produced in the upper San Joaquin Valley and similar regions from the varieties of grapes growing there, simply by ordinary attention to cleanliness, the sterilization of cooperage, and more than ordinary attention to the control of temperature.

For white wines a thorough preliminary defecation of the must by means of sulfur fumes and the use of pure yeast or yeast starters is advisable.

For red wines some form of cooling machine is essential, and the temperature of the fermenting wine should never exceed 95° F., and if possible should be kept below 92° F. This can be easily and perfectly done by means of the cooling machine described in Bulletin No. 174.

The grapes both for white and red wines should be thoroughly ripe. Ripeness must be determined by the flavor and appearance of the grapes more than by the amount of sugar they contain. We can not hope to get the best results from imperfectly ripe grapes even if they contain 22% of sugar. Some varieties in the climate of the San Joaquin Valley are not perfectly mature for wine-making purposes until they contain 25% of sugar or more. Better results are to be obtained by diluting and, if necessary, adding tartaric or citric acid to over-ripe grapes in this region than by attempting to make wine from under-ripe grapes which have not developed the color, body, and flavor necessary for the production of good wine.

Finally, the claims made in Bulletin No. 167 for the new method of wine-making have been abundantly verified by these experiments. The preliminary extraction of color, tannin, and body by means of heating before fermentation has utilized more perfectly than any other method tested, all the good qualities of the grapes and remedied more completely the bad qualities. The wines made by this method have shown better color and flavor, have developed and kept better, and have in every way shown themselves superior to the others. The only thing remaining to be tested regarding it is the cost when carried out on a large scale. For this purpose a plan of a cellar suitable for the use of this method, and the mode of operation with this plan, are given. While the method could be adapted to any cellar without changing the vats or casks at present in use, it would be much simpler and more easily managed in a cellar specially constructed for the purpose.

The plan as given provides only for the manufacture of dry red wine. The addition of some defecating vats would make it equally adapted to the making of dry white wine. The manufacture of sweet wines would be better done in a separate crushing and fermenting room adjoining, though it could be done with the same machinery. It is at present

doubtful if the heating method could be adapted to the manufacture of port wine. The experiments at present indicate that too much tannin would be extracted for the best port. It might be possible to modify the method so as to make it applicable to this purpose, but at present this seems hardly necessary, and the improvements in the manufacture of port will probably lie in the direction of cool fermentations and long maceration of the pomace.

PLAN OF FERMENTING ROOM TO WORK 50 TONS OF RED GRAPES PER DAY.

Explanation of Figures 12 and 13.

Fifty tons per day = 11,000 gallons of crushed and stemmed grapes.
Fifty tons per day = 8,300 gallons of wine = 250,000 gallons per season of thirty days.
(By working continuously 400,000 gallons per season could be handled with the same installation.)

H. Four extracting vats, 12 feet by 12 feet by 12 feet; capacity, 13,000 gallons. (11,000 gallons will fill them to within 19 inches of the top.)

D. Two drainage vats, 12 feet by 12 feet by 6 feet; capacity, 6,500 gallons.

F. Six fermenting vats, 20 feet by 10 feet by 6 feet 6 inches; capacity, 9,000 gallons. (8,500 gallons will fill them to within 10 inches of the top.)

W. Two pump wells to hold 250 gallons.

E. Gomot heater to heat 1,000 gallons of must from 70° to 150° F. in one hour.

C. Cooler consisting of 240 feet of 1½-inch copper pipe and 3-inch No. 10 canvas hose. (Will cool 1,000 gallons of must from 125° to 80° F. in one hour with 1,000 gallons of water at 70° F.)

P. Two pumps to handle 1,500 gallons per hour each.

K. Two cooling coils consisting of 80 feet of 1-inch copper tubing (Maximum cooling effect needed, allowing 50% for cooling by radiation (See Bulletin No. 174, p. 18), requires 125 gallons of water at 70° F. per hour for 72 hours for each vat. This equals 9,000 gallons for each vat or each day. This will keep the wine below 92° F.)

T. Carrier for crushed grapes.

S. Carrier and strainer for crushed grapes.

L. Strainer at bottom of heating vat.

R. Crushing platform.

M. Must sump to receive must from strainer S.

Y. Carrier for extracted pomace.

b. Pipe leading from heater to heating vats.

a. Pipe leading from well of strainer to drainage vats.

o. Manholes for removal of extracted pomace.

e. Pipe for conducting heated must to pump well.

r. Pipe for conducting cold must into drainage vats.

Method of Operation.—1. The grapes are crushed and stemmed in the ordinary manner on the crushing platform (R). A solution of

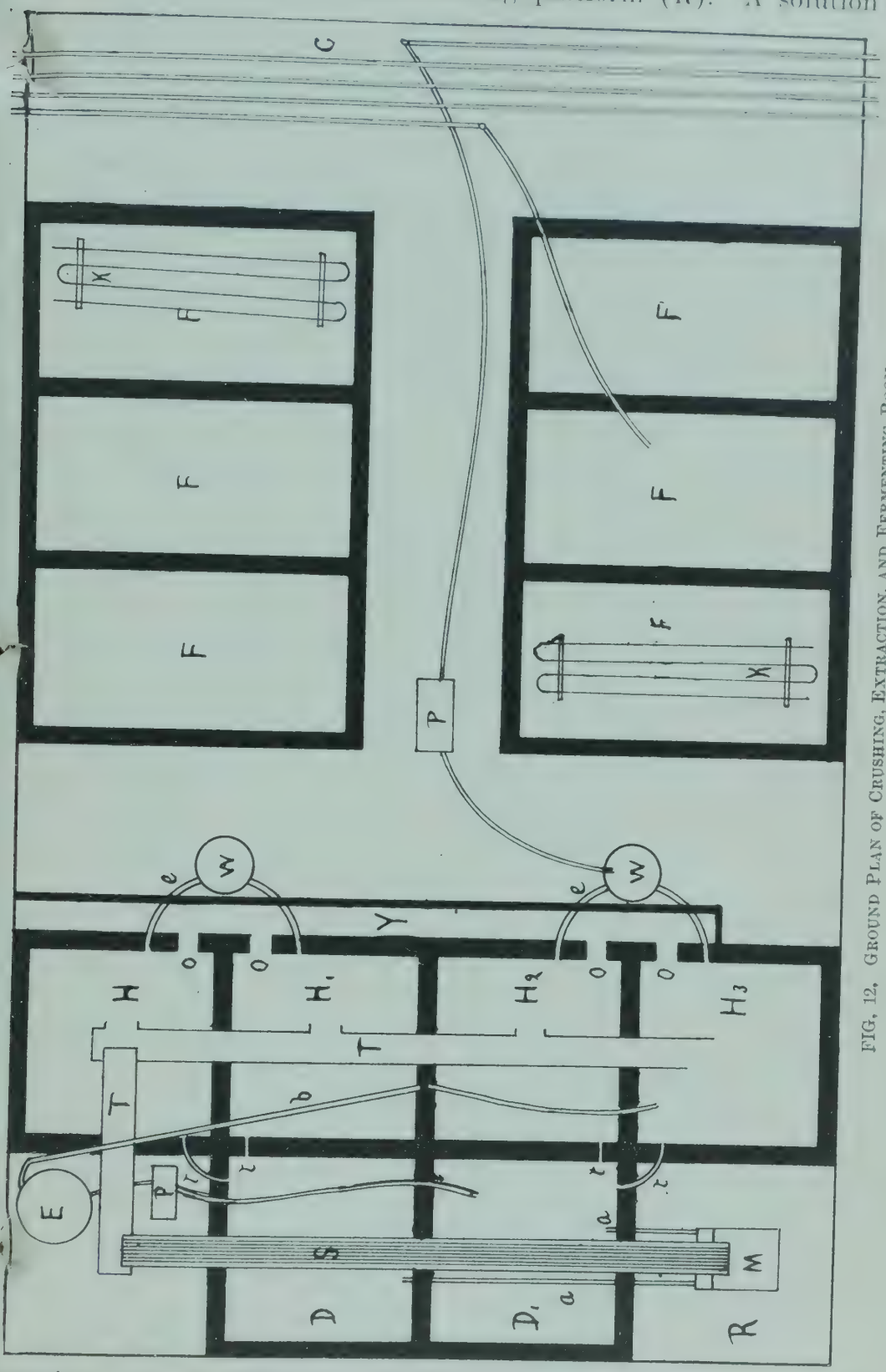


FIG. 12. GROUND PLAN OF CRUSHING, EXTRACTION, AND FERMENTING ROOM.

potassium meta-bisulfite is gradually added to the crushed grapes as they pass from the crusher. The solution is made by dissolving 80

pounds of the salt in 100 gallons of water, and is used at the rate of one gallon to every ton of crushed grapes. This is equivalent to .2 per mil. of SO_2, and is sufficient to prevent fermentation until the extraction can be accomplished, and helps to dissolve the color of the skins, and to prevent the must from becoming oxidized.

2. The crushed grapes are carried by an ordinary drag-carrier up the strainer (S) and along the flume (T) to the extraction vat which is being used. The strainer (S) is similar to the usual box flume used in wineries, except that it is provided with a false bottom consisting of longitudinal slats, which permit a large portion of the must to run back into the must sump (M).

3. The must is then allowed to run from M and from the extraction vat into one of the drainage vats (D).

4. As soon as the drainage vat is nearly full, or any time within twelve hours, the must is passed through the Gomot heater (E) and pumped back on to the top of the grape skins in the extraction vat. The opening (*r*) at the bottom of the extraction vat is meanwhile left open so that the hot must entering at the top will drive out the cold must at the bottom into the drainage vat.

5. As soon as the must, flowing from the extraction vat into the drainage vat, shows a rise in temperature the heater is connected with the opening (*r*) at the bottom of the extraction vat. The stream of hot must now enters the extraction vat from the bottom below the strainer (L), and being hotter and therefore lighter than the rest of the must in the vat will tend to rise and thus to equalize the temperature in all parts of the vat of crushed grapes. In this way the skins will all be thoroughly heated, and the extraction completed without stirring or using the heater on half-heated must, which would result in a loss of efficiency.

The temperature to which it will be necessary to raise the must as it passes through the heater will depend on the initial temperature of the grapes and on the amount of must which it is possible to separate. By proceeding in the way described, it would undoubtedly be possible to separate an amount of must equal to two-thirds the volume of the grapes, or about 145 gallons per ton. If the temperature of the grapes therefore was 70° F., and the must was passed through the heater at a temperature of 153° F., the whole contents of the extracting vat would be raised to 125° F., which is the temperature required.

6. If necessary to hasten or complete extraction, the must should be allowed to run into the pump well (W) and returned to the top of the pomace in the extracting vat.

7. It is then allowed to stand for sufficient time to extract the necessary color and tannin. This time will differ according to the kind of grape, the kind of wine desired, and the temperature of extraction. If the temperature of 125° F. is used the time of extraction will be from

four to eight hours. With higher temperatures it will be less, with lower more. Lower temperatures and long maceration will give more tannin; higher temperatures with shorter maceration will give less tannin for a given amount of color. This is due probably to the extraction of tannin from the seeds which takes place after long contact with the hot must.

8. As soon as the extraction is complete, the hot must, containing color and tannin, is allowed to run into the pump well (W) and pumped through the cooler (C) into a fermenting vat (F). The temperature of the must when it reaches the fermenting vat should be about 80° F. The must as it passes from the cooler (C) into the fermenting vat should be allowed to fall through the air in order to aërate it thoroughly. This is essential for a quick and thorough fermentation.

9. As the fermenting vat is being filled, about 75 gallons of yeast should be added. This yeast may be prepared as described on page 13, or it may be simply some fermenting wine taken from one of the other vats that is in full fermentation. The use of pure yeast as described is preferable, as the actual amount of yeast added is more easily controlled. If we use 75 gallons of fermenting wine from another vat the amount of yeast in it, and still more the character of it, will vary very

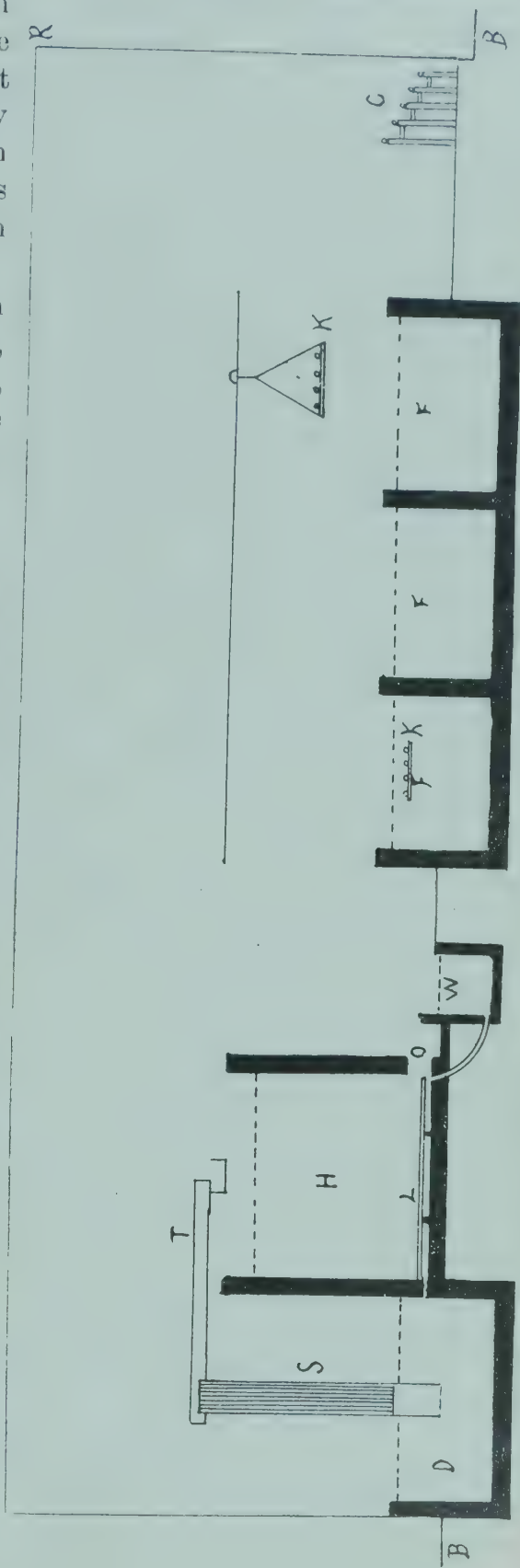


FIG. 13. VERTICAL SECTION OF PLAN SHOWN IN FIG. 12. (See p. 31.)
B. Ground level. R. Roof. H. Extraction vat. D. Drainage vat. F. Fermentation vat.

much according to the stage of fermentation at which the wine has arrived. Yeast prepared by the method indicated will always be in full vigor and the number of active cells present will be fairly constant. This will cause the fermentations to be more regular and simplify the control of temperature.

10. As soon as the must ceases to run from the extraction vat the gate (O) is opened and the pomace shoveled out to the carrier (Y), which takes it to a continuous press. The must from the press is mixed with that already in the vat. It will probably be unnecessary to cool the press must.

11. Fermentation will start immediately, and as soon as the temperature rises to 90° F. one of the cooling coils (K) should be lowered into the must a couple of inches below the surface and water run through it. No stirring of the fermenting liquid will be necessary, as the heating must rises to the surface, is cooled on contact with the copper coil, and sinks again. This keeps up a constant circulation. A moderate aëration should be given once a day, either by pumping-over or by means of an air compressor. Unless this is done the fermentation will be inconveniently slow. If too much aëration is given the quality and color of the wine will be injured.

12. At the end of three days the wine should not contain more than 1% or 2% of sugar and should mark 0 on the saccharometer. It should then be transferred to the storage cellar, being given a thorough aëration in the transfer.

Figure 14 shows the sequence in which the various vats shown in Figs. 12 and 13 would have to be used. Each circle represents a vat.

Each column represents a day, and shows the condition of all the vats on the day indicated at the head of the column.

Each horizontal file shows the condition of a vat on the various days indicated.

Each heavy line represents the course of the must handled on a single day. For example, on the first day the must from the crusher falls into extraction vat H and runs into drainage vat D. On the second day it is taken from D, passed through the heater and back into H. On the third day the must, now containing color and tannin, is taken from H and passed through the cooler into fermenting vat F. It stays in F during the fourth, fifth, and sixth days, and is transferred to a storage cask on the seventh. When everything is in full running, as on the seventh day, and as indicated in the figure, one of the extraction vats (H_1) is being filled from the crusher. The cold must from H_1 is draining into one of the drainage vats (D). Another extraction vat (H_2) is being heated by the must from the other drainage vat (D_1). Another extraction vat (H) is being drawn off and the hot red must

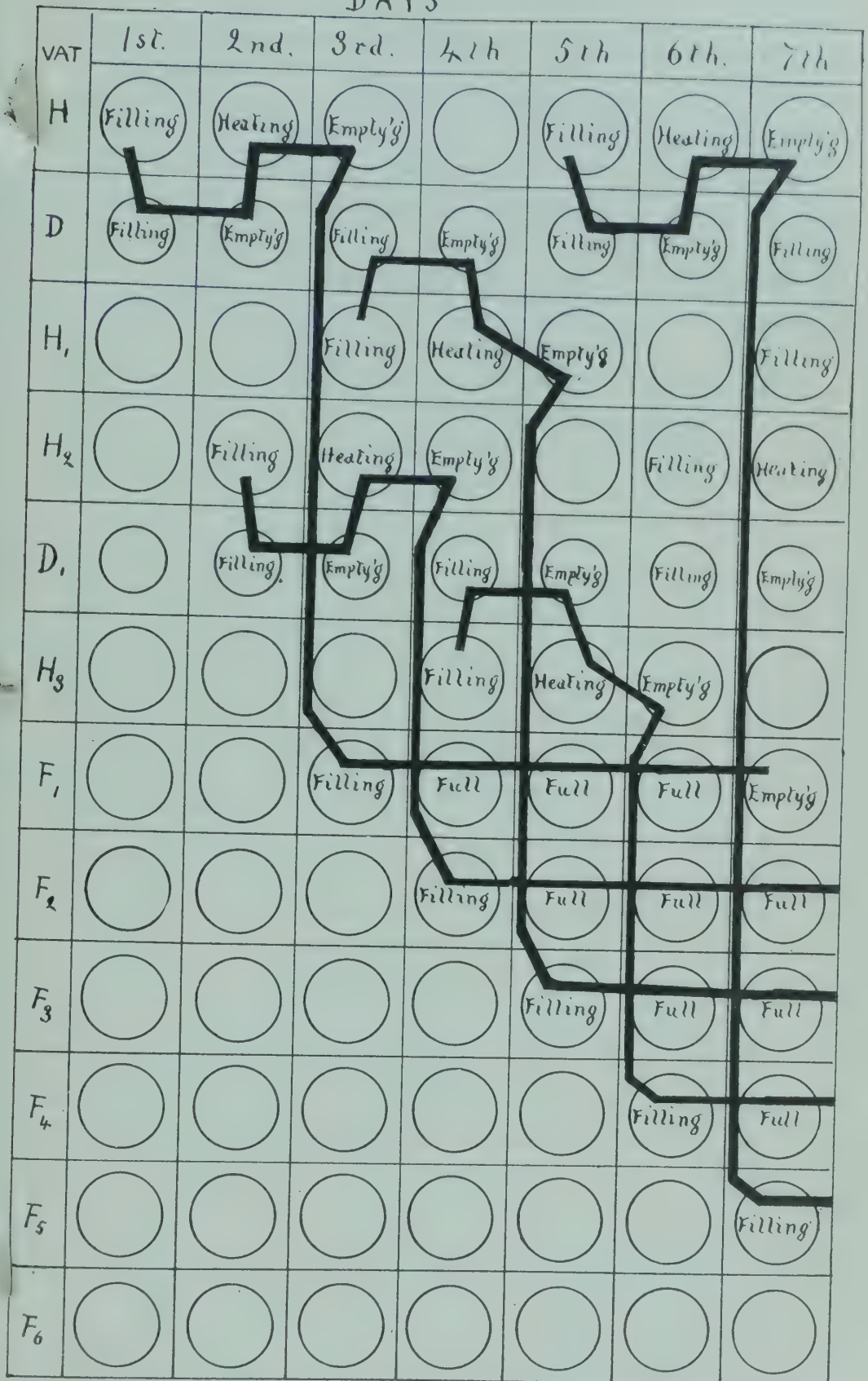


FIG. 14. Diagram showing order in which vats must be used.

passed through the cooler into one of the fermenting vats (F_5). The fourth extraction vat (H_3) is empty and being prepared for filling on the following day. Three of the fermenting vats (F_2, F_3 and F_4) are full of fermenting wine, and one (F_1) is being emptied of fermented wine. The sixth fermenting vat (F_6) is empty and ready for filling the following day.

The whole process could be very much shortened if needed. The extraction, instead of taking seventy-two hours as indicated, could be better done in thirty-six hours, and the must need not stay in the fermenting vats, from the commencement of filling to the end of emptying, more than four days. In this way the output could be increased from 8,300 gallons per day of twenty-four hours to over 13,000 gallons; and with the addition of another fermenting vat and a corresponding increase of the cooling apparatus to 15,000 gallons per day.

ACKNOWLEDGMENTS.

The successful carrying out of the foregoing experiments was rendered possible by the coöperation of members and employés of the California Wine Association, who provided all the necessary grapes and cellar facilities and assisted materially by their interest and coöperation.

Our thanks are also especially due to Messrs. T. R. Meakin and son, whose advice and skill in constructing the needful apparatus very much facilitated every stage of the work; and to Mr. B. J. Wingfield, who carefully and skillfully attended to all the details of the experiments.

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1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-1903.
1904. Twenty-second Report of the Agricultural Experiment Station for 1903-1904.

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AGRICULTURAL EXPERIMENT STATION.

COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.

BULLETIN No. 179.

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COMMERCIAL FERTILIZERS.

By GEORGE ROBERTS.*

This report gives the results of fertilizer inspection work for the second half of the fiscal year 1905-06, the results of the first half-year having been published in Bulletin No. 173. A list of the registered dealers was given in Bulletin No. 173 and will not be repeated.

From January 1 to June 30, 1906, 239 samples of registered fertilizers and fertilizing materials have been received at the laboratory. Of this number, 22 were sent by farmers under the two-dollar fee provision, 56 were taken by inspectors from purchasers' goods upon the request of the purchasers, and 161 were taken by inspectors from goods in the hands of agents and manufacturers. During the first half-year 138 registered samples were received and analyzed, making a total of 377 samples for the year.

The following classification may be made of samples reported in this bulletin:

Complete fertilizers	121
Bone meal	27
Tankage	42
Nitrogenous superphosphate	1
Superphosphate and potash	4
Superphosphate	1
Thomas phosphate powder	7
Dried blood	14
Nitrate of soda	14
Bird guano	1
Sulfate of potash	7
Total	239

DEFICIENCIES.

In the analyses of the above samples, the following number of deficiencies greater than allowed by law occur:

Available phosphoric acid (total when available is not guaranteed)	19
Total nitrogen	35
Potash	20
In valuation	11

These deficiencies were found in 67 samples.

The fertilizer law allows a deficiency of 0.25 per cent in nitrogen, 0.50 per cent in potash, and 1.00 per cent in available phosphoric acid.

* The writer is much indebted to Mr. Ludwig Rosenstein, assistant in the Fertilizer Control Laboratory, for his faithful and very accurate work.

INSPECTION SERVICE.

Beginning with July 1, 1905, the plan was adopted of placing resident sampling agents in those localities in which the sales of fertilizers were large enough to justify the action. Accordingly Mr. A. C. Pickett of Riverside was appointed sampling agent for southern California, with headquarters at Riverside. His instructions were to make two general inspections a year—one immediately following July 1st, and the other immediately following January 1st. He was directed to sample all goods found in the hands of agents and dealers, and also to sample goods in the hands of purchasers upon their request. In addition to these duties he was instructed to keep himself posted on the shipment of fertilizers in his section and to go and sample them whenever the distance would permit, or the amount of goods justify the trip. He was also instructed to sample goods upon request of purchasers at all times when distance and quantity of goods would justify the work. Notice of this plan was printed in a large number of papers in southern California. To illustrate the effectiveness of the plan the following figures are given:

From July 1, 1905, to June 30, 1906, Mr. Pickett took 305 samples. What was done from January 1 to June 30 will probably better represent the effectiveness of the plan, for the reason that it was probably not generally known until this time, and also that this is the period of greatest sales. During these six months Mr. Pickett took 202 samples, 56 of which were taken upon the request of purchasers.

This plan of inspection has proven so satisfactory that it will be introduced in other localities whenever the sales are large enough to justify the step.

Some of the farmers in this section bought their fertilizers subject to settlement upon basis of Fertilizer Control analyses and called upon Mr. Pickett to sample the goods. This is a good practice, and when agreed upon by dealer and purchaser, the Fertilizer Control will be glad to render prompt service in the matter of analyses.

The above plan does not interfere with farmers sending their own samples under the two-dollar fee provision of the law. Samples sent by farmers with the fee will receive first attention, those taken by inspectors from purchasers' goods next, and then those taken from stocks of dealers.

A WORD ABOUT BUYING FERTILIZERS.

There is one reform that is much needed in the purchase of fertilizers, and that is a change from the almost universal practice of buying on the flat ton rate. When fertilizers are bought on this basis, farmers often pay practically the same price for different fertilizers whose compositions necessarily make their commercial values vary consider-

ably, and one may rest assured that he pays too much for the brand of lower value instead of too little for the brand of higher value. The brand or name stands for what the manufacturer thinks is best suited for the crop for which the brand is intended, or else it stands for what the manufacturer wishes the farmer to think is best suited for his crop, in order that the manufacturer may dispose of, at best advantage to himself, fertilizing materials on which he has a corner, or which he can procure on more favorable terms than others. It is too often the case that the immediate financial returns influence the agent's theory of fertilization. Thus it is that some dealers will declare that experience has definitely settled it that organic nitrogen from animal sources is best for most, if not all, crops, and these are the dealers who are directly or indirectly interested in the packing industries. On the other hand, some are very positive that nitrate of soda should be the source of the greater part of the nitrogen, and investigation might disclose the fact that nitrogen in nitrate of soda is the cheapest form for this class of manufacturers. Some will declare with authority that superphosphate made from phosphate rock is superior to superphosphate made from bone, and *vice versa* (when there is no difference), and one does not have to look very far to find that each party is interested in the material which he advocates. Still others will say that non-acidulated bone is the best form of phosphoric acid, and it would not be surprising to find that the dealer in this class finds greater profit in handling untreated bone, or else that he is not prepared to acidulate his materials.

It is not intended to discuss here what materials are best suited for various crops under various conditions, but to suggest to the buyers of fertilizers that they should know what they want and then go to the fertilizer dealer to supply their wants. In short, it is intended to suggest to the farmer the advantages of buying fertilizing ingredients at a *definite price per unit*, instead of buying "brands" of fertilizers on the flat ton basis. The fertilizing ingredients may be bought in the unmixed materials, or they may be bought mixed in proportions which seem best suited to the farmer's need, but in either case the transaction should be on the unit basis. A unit of a fertilizing ingredient is *one per cent* in a ton. Thus if nitrate of soda contains 15½ per cent of nitrogen, one ton contains 15½ units of nitrogen. In other words, the figures that are used in expressing the guaranteed analysis express the number of units in a ton of the material.

Buying fertilizers on the unit basis means that the dealer must state how much he is charging per unit for available and insoluble phosphoric acid, or if he does not guarantee available and insoluble phosphoric acid, how much he is charging per unit for total phosphoric acid: how much per unit for each form of nitrogen, and how much per unit for potash. This then puts the purchase of fertilizers strictly on

a competitive basis, and the buyer is at once able to say who is giving him plant food at the lowest price. It does away with all hidden virtues which lurk in the "so much per ton" mixed fertilizers. Of course throughout the transaction the farmer must not lose sight of the quality of the materials used and the mechanical condition of the fertilizer.

This basis of purchase also affords a just basis of settlement in case goods do not come up to guaranty. If the fertilizer has fallen short in one or more ingredients it is a simple matter of arithmetic to arrive at what should be paid for the goods on the basis of the agreed price. The farmer should never forget that he is buying and using pounds of nitrogen, phosphoric acid, and potash, and not tons of "fertilizer."

It is not sufficient for the dealer to quote a price per ton and say that this price is made up on a reasonable price per unit for the ingredients. The price per unit for each ingredient should be given.

If farmers would stand together in demanding this basis of dealing, it would be a very easy matter to obtain it. If the manufacturer objects to this plan, the farmer may remind him that it is the basis on which he buys his own materials. If it is good for the manufacturer, why is it not good for the farmer?

The question is often asked, Is it better to buy mixed fertilizers, or to buy the materials and mix them on the farm? The answer is very simple. If the manufacturer mixes them better and cheaper than the farmer can mix them, then buy them mixed. The question of cost of mixing can be determined by getting the cost of ingredients in the unmixed materials and in the ready-mixed fertilizers.

All the materials which enter into the mixed fertilizers may be bought unmixed in the market. But in buying the unmixed materials care should always be exercised to obtain them in a finely ground condition. In mixing them, the bulkiest material should be placed in an even layer upon a tight floor, the others above this in order of bulk, then begin at one end and shovel the pile back. Repeat the operation once or twice, or until the materials are well mixed.

THE FERTILIZER LAW.

The text of the California fertilizer law is given in Bulletin No. 171, which will be sent free to applicants as long as the issue lasts.

ANALYSES FOR CONSUMERS.*

Any user of fertilizers may, by paying the fee of two dollars specified by Section 4 of the fertilizer law, have a sample of his material analyzed.

* Considerable matter which has appeared in former reports is repeated in this bulletin for the reason that it is considered important to keep it before the attention of the farmers.

This fee is not to be regarded as paying the cost of the analysis. It is a nominal charge made to prevent the sending of samples through curiosity, as is always the case when analyses are made free of charge.

The sample should be drawn from not less than ten packages, if the lot is five tons or less; if the lot is over five tons, the sample should be drawn from not less than twenty packages. The larger the number of packages sampled, the more representative the sample will be. The sample drawn as specified above should be thoroughly mixed, great care being exercised to prevent the separation of coarse and fine materials. Not less than one quart should be taken from this sample, to be sent to the Station for analysis. Whenever possible the sampling should be done in the presence of the agent, who should sign, as a witness, the certificate given below. If the sample is not drawn in the presence of the agent, it should be drawn in the presence of some other person, who should sign the certificate as a witness.

Samples for consumers will be given preference in the laboratory and the results will be reported as soon as possible. The sample should be sent, if possible, in time to receive the report before the fertilizer is used, in order that recourse may be had to the original packages in case of controversy with the manufacturer.

The form of certificate given below should be used in sending samples for analysis. Blank forms will be furnished upon application. All samples should be marked in some way so that they may be identified. Samples should be sent prepaid, addressed to the Fertilizer Control, Experiment Station, Berkeley, and should bear the name and address of the sender. Bank checks and money orders should be made payable to "The Regents of the University of California." Letters, certificates, and remittances should not be enclosed with the samples, but mailed separately. When the report of analysis is received, a tag or label taken from one of the bags sampled should at once be sent to the Station, and the name and address of the agent from whom the goods were purchased should be given. Analyses will be made only for those who purchase fertilizers for their own use. Any one refusing to send a tag or label as specified above will be excluded from further privileges under the above provisions.

CERTIFICATE FOR CONSUMER'S ANALYSIS.

Director Agricultural Experiment Station, University of California,
Berkeley, California.

This is to certify that I am not a dealer in, or agent for the sale of any fertilizer, and that the fertilizer, a sample of which I have sent you for analysis, was purchased by me....., 190.., for my own use and not for sale.

I further certify that the amount purchased was.....tons and that the sample was drawn from.....packages and was thoroughly mixed.

Upon receipt of the analysis from you, I agree to furnish you with a tag or label taken from one of the packages sampled, and the name and address of the firm or agent of whom the fertilizer was purchased. I enclose two dollars analysis fee.

(Signature) .....

(P. O. Address) .....

(Date) .....

(Signature of Witness)

.....

VALUATION OF FERTILIZERS.

The "agricultural value" and the "commercial value" of fertilizing materials are not synonymous terms. The agricultural value of a fertilizer is determined by the increase and quality produced by it in the crop. The commercial value of a fertilizer is determined by the cost of the materials which enter into its composition. A fertilizing material of high commercial value may have a low agricultural value on a particular soil or crop. On another soil or crop the same material may have a high agricultural value.

In calculating the values given in this report the Experiment Station does not undertake to say what the retail prices of fertilizers should be in this State. The values given are for the amounts of the unmixed raw matetrials of good quality represented by the analyses, and do not take into account the cost of grinding, mixing, bagging, insurance, drayage, agent's commission, and other expenses of the manufacturer. Hence the valuations in this report are generally lower than the retail prices of fertilizers. The schedule of values used is given below. They represents, as nearly as can be determined, the prices at which fertilizing ingredients in raw materials of good quality can be bought at retail for cash at the warehouses in our largest markets like San Francisco. It is a difficult matter to get quotations on fertilizing materials in our market that agree closely enough to serve as a basis for a schedule that represents the actual market conditions. Taken as a whole, it is believed that the schedule used is fairly close to the market conditions.

The estimation of values is not without its use, even if the schedule used does not represent the actual market conditions. In the first place, a comparison of values calculated upon the guaranty and the analysis shows whether the goods have the commercial value represented by the guaranteed analysis. In the second place, the calculation of values upon different guaranteed analyses enables the purchaser to determine which dealer offers him plant food at the lowest price; provided, of course, that the materials offered are of the same quality.

In reading the report of analyses, the column of values is the last one to be considered. The first things to consider are the materials used and the analysis as compared with the guaranty. From the very

nature of the case the analysis must differ somewhat from the guaranty, but the variation should not be so great as to change the nature of the fertilizer. Such a variation might take place, and at the same time the value calculated upon the guaranty be greater than the value calculated upon the analysis. Suppose, for example, that a fertilizer should be guaranteed to have the composition indicated by the first column below, and upon analysis it should show the composition indicated by the second column.

	Guaranteed.	Found.
Available phosphoric acid	8 per cent.	10 per cent.
Insoluble phosphoric acid	2 "	2 "
Total phosphoric acid	10 "	12 "
Nitrogen	3 "	3 "
Potash	5 "	3 "

According to the schedule of values now in use these two compositions would have the same commercial value, yet they are essentially different. Such variations as the above are sometimes met with.

SCHEDULE OF TRADE VALUES.

	Cents per Pound.	Value per Unit.
Phosphoric Acid.		
Available (water- and citrate-soluble)	6	$1 20
Insoluble in mixed fertilizers	2½	0 50
Insoluble in plain acid phosphate	0	0 00
In fine* bone and tankage	4½†	0 90
In medium* bone and tankage	3½†	0 70
In fine* Thomas phosphate powder	5†	1 00
In medium* Thomas phosphate powder	3†	0 60
Nitrogen.		
In ammonia salts	18	3 60
In nitrates	16½	3 30
Organic in—		
Blood	18½	3 70
Mixed fertilizers	18	3 60
Fine* bone and tankage	18†	3 60
Medium* bone and tankage	14†	2 80
Potash.		
From sulfate	6	1 20
From muriate	5	1 00

To calculate the value per ton of a fertilizer, multiply the pound value of each ingredient by 20, then multiply these products by the percentages of the several ingredients, and add the results.

* Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas phosphate powder by a 100-mesh sieve.

† For the purpose of calculating comparative values an average value of 4 cents per pound for phosphoric acid and 17 cents for nitrogen is used on bone meal and tankage; an average of 4½ cents per pound is used for phosphoric acid in Thomas phosphate powder.

For example:

	Value per lb.	Analysis per cent.	
Available phosphoric acid	6 cents	× 20 × 8.00 =	$9 60
Insoluble phosphoric acid	2½ "	× 20 × 2.00 =	1 00
Total phosphoric acid		10.00	
Nitrogen in nitrates	16½ cents	× 20 × 1.50 =	4 95
Organic nitrogen	18 "	× 20 × 2.50 =	9 00
Total nitrogen		4.00	
Potash from sulfate	6 cents	× 20 × 4.00 =	4 80
Value per ton			$29 35

Or multiply the unit value given in the schedule of values by the percentage of the ingredient, and add the products.

IMPORTANT.

Caution to Purchasers of Fertilizers.

Farmers are requested not to purchase fertilizers that are not labeled to meet the requirements of law, and not to attempt to purchase them from any one but registered dealers or their authorized agents. Any farmer who purchases fertilizers under any other conditions does not deserve the protection of the law, and the manufacturer or dealer who does not label his goods according to the full requirements of the law is liable to prosecution and should in nowise be patronized by farmers. It is quite liable to happen and does happen that now and then a manufacturer may miss his guaranty without intending to do so, but it is impossible that he would have his labels printed in non-conformity to the law without doing so either intentionally or through gross carelessness. Farmers can render great assistance in enforcing the law by observing the above caution.

Every bag or package of fertilizer and fertilizing material, whether a regular brand or a special mixture, should carry a label or tag bearing the following:

1. Name and address of manufacturer and place of manufacture.
2. Registration number.
3. Name or brand of fertilizer.
4. Guaranteed analysis, giving percentage of

Available phosphoric acid;	Nitrogen in ammonia salts;
Insoluble phosphoric acid;	Potash.
Total phosphoric acid.	Total nitrogen.
Nitrogen in nitrates;	Organic nitrogen;

Or such of these ingredients as may be present.

5. A statement of the materials from which the above ingredients are derived.

In case of bone meal, tankage, and Thomas phosphate powder, a guaranty of available phosphoric acid is not required when these materials are not acidulated.

No dealer or manufacturer, except those who have certificates of registration from the University of California, and their authorized

pany has any right to use any registration number except in connection tion with the firm name to which the registration certificate of such number has been issued; and no person or company to whom a registration number has been assigned has any right to give any other person or company permission to use said registration number, and any number so used is a fraud. No agent has any right to use his principal's registration number in connection with his own name.

REPORT OF ANALYSES.

The following tables give the results of all analyses made from January 1 to June 30, 1906.

Available phosphoric acid is not determined in bone meal, tankage, and Thomas phosphate powder, unless requested. The fineness of these materials is determined, fine and medium bone being separated by a sieve of 50 meshes to the inch; tankage by a 25-mesh sieve; and Thomas phosphate powder by a 100-mesh sieve.

Some fertilizers containing all three ingredients are rated as tankage, because they are non-acidulated tankage products with potash salts added, and do not carry a guaranty of available phosphoric acid.

Nitrogen in ammonia salts will, in some cases, be found reported when nitrogen in this form is not guaranteed. In some of such cases this form of nitrogen is produced by conversion of organic nitrogen during process of manufacture, and is not to be considered a deviation from guaranty of materials used. This form is not reported separately when less than 0.20 per cent, unless it has been guaranteed, but is included in the total. Guanos carry more or less nitrogen in nitrates and ammonia salts, and when any appreciable quantity of guano is used the manufacturer should take into account the fact that some nitrogen will show as nitrates and ammonia salts. The failure to take this into consideration may perhaps account for the appearance of these forms of nitrogen in some samples in which only organic nitrogen was guaranteed.

The percentage of chlorin is given when it exceeds 0.50 per cent. It is a matter of only technical interest whether chlorin present is from muriate of potash, kainit, or from common salt that may be in some of the materials used. If a manufacturer uses sulfate of potash and uses a tankage with it containing a large amount of chlorin, from a practical standpoint he has lowered the grade of his fertilizer just as much as if he had used muriate of potash instead of sulfate of potash. Chlorin from all other sources is as objectionable as from muriate of potash. However, if muriate of potash is found when sulfate is guaranteed, the fact will be published.

The following abbreviations are used in the tables: Bl = blood; Bn = bone; Fs = fish; G = guano; Super = superphosphate; T = tankage.

Guaranties are entered in *italics*. Deficiencies greater than allowed by law are entered in bold type.

ANALYSES AND VALUATIONS.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Agricultural Chemical Works, Los Angeles, Cal.		
610*	Blood and bone (Tankage)	T. G. Otis, Pomona	$25.60
624*	do	Thomas Moffatt, Rialto	26.09
637*	do	E. A. Moore, Redlands	25.08
	Guaranteed		*26.50*
680	Pure Blood Meal	Manufacturers	50.76
	Guaranteed		*49.95*
638*	Fine Ground Bone	E. A. Moore, Redlands	30.21
	Guaranteed		*27.80*
687*	Fine Ground Bone	Upland Feed and Fuel Co., Upland	30.63
	Guaranteed		*26.10*
598*	Guano Phosphate	J. S. Kuns, Covina	**24.60**
648*	do	J. H. Payne, Upland	30.25
649*	do	P. W. Strong, Upland	29.82
650*	do	W. S. McGiffert, Covina	29.96
	Guaranteed		*32.35*
591*	Nitrate of Soda	E. A. Moore, Redlands	**46.33**
592	do	Thomas Moffatt, Rialto	51.05
663	do	E. A. Moore, Redlands	51.81
664	do	E. A. Moore, Redlands	51.61
	Guaranteed		*51.15*
639	No. 1 Orange and Lemon	E. A. Moore, Redlands	30.05
698	do	Upland Feed and Fuel Co., Upland	29.35
792	do	T. E. Ketcheson, Upland	26.22
	Guaranteed		*28.60*
611	Special Orange and Lemon Fertilizer	A. C. Pickett, Riverside	26.09
	Guaranteed		*25.70*
701	Special	Upland Feed and Fuel Co., Upland	26.80
	Guaranteed		*23.85*
788	Special Orange and Lemon Fertilizer	B. K. Brant, Upland	28.30
	Guaranteed		*29.70*
588	Special Orange and Lemon Fertilizer	A. L. Wright, Rialto	26.35
	Guaranteed		*24.92*
640	Special Orange and Lemon for Heavy Soils	E. A. Moore, Redlands	28.03
	Guaranteed		*23.30*
625	Special Orange and Lemon for Light Soils	Thos. Moffatt, Rialto	28.35
699	do	Manufacturers, Los Angeles	26.25
	Guaranteed		*23.50*
641	Riverside Special Orange and Lemon	E. A. Moore, Redlands	26.49
	Guaranteed		*25.60*
642	Riverside Special Orange and Lemon	E. A. Moore, Redlands	26.08
700	do	Upland Feed and Fuel Co., Upland	27.84
	Guaranteed		*26.20*
583	Sulfate of Potash	James Moffatt, Rialto	**58.75**
	Guaranteed		*60.00*
	American Agricultural Chemical Co., Los Angeles, Cal.		
653	Acid Phosphate	G. W. Joslin, North Pomona	26.80
	Guaranteed		*19.20*
626	Bradley's Fruit and Vine	Mrs. M. E. Wallace, Rialto	26.28
	Guaranteed		*24.66*
643	Bradley's Lawn	Graham-Cope Com'l Co., Redlands	26.48
645	do	Pacific Wood and Coal Co., San Diego	27.33
	Guaranteed		*27.11*

*610—79 per cent fine.
*624—78 per cent fine.
*637—75 per cent fine.
*598—Some dried blood.
*648—Considerable dried blood.
*649—Considerable dried blood.

ANALYSES AND VALUATIONS.

Pounds Per Hundred.

Laboratory Number	Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
610	------	------	15.13	------	------	------	3.97	----------	**3.97**	------	------	------	0 76
624	------	------	14.09	------	------	------	4.36	----------	4.36	------	------	------	0 60
637	------	------	13.16	------	------	------	4.28	----------	4.28	------	------	------	0 68
----	------	------	*14.00*	------	------	------	*4.50*	----------	*4.50*	------	------	------	----
680	------	------	------	------	------	------	13.72	----------	13.72	------	------	------	----
----	------	------	------	------	------	------	*13.50*	----------	*13.50*	------	------	------	----
638	------	------	**20.13**	------	------	------	4.15	----------	4.15	------	------	------	----
----	------	------	*22.00*	------	------	------	*3.00*	----------	*3.00*	------	------	------	----
687	------	------	**20.47**	------	------	------	4.19	----------	4 19	------	------	------	----
----	------	------	*22.00*	------	------	------	*2.50*	----------	*2.50*	------	------	------	----
598	**9.09**	1.35	10.44	------	1.59	0.28	0.57	----------	2.44	------	3.92	----	----
648	**12.40**	1.99	14.39	------	0.38	0.19	2.11	----------	2.68	------	4.03	------	----
649	13.65	2.39	16.04	------	0.75	0.17	1.15	----------	**2.07**	------	4.19	------	----
650	**12.53**	1.53	14.06	------	0.43	0.50	1.69	----------	2.62	------	4.05	------	----
----	*14.00*	*4.00*	*18.00*	------	------	------	*2.50*	----------	*2.50*	------	*4.00*	------	----
591	------	------	------	------	14.04	------	------	----------	**14.04**	------	------	------	5.79*
592	------	------	------	------	15.47	------	------	----------	15.47	------	------	------	0 74
663	------	------	------	------	15.70	------	------	----------	15.70	------	------	------	----
664	------	------	------	------	15.64	------	------	----------	15.64	------	------	------	----
----	------	------	------	------	*15.50*	------	------	----------	*15.50*	------	------	------	----
639	5.77	4.43	10.00	------	0.78	------	3.35	----------	4.13	------	5.23	------	0 70
698	6.25	3.59	9.84	------	1.48	------	2.37	----------	3.85	------	5.54	------	----
792	5.54	2.60	8.14	Bn, T Super	1.63	------	2.09	----------	**3.74**	------	**4.48**	------	----
----	*5.00*	*5.00*	*10.00*		*1.00*	------	*3.00*	Bl, Bn, T	*4.00*	------	*5.00*	------	----
611	5.98	3.97	9.95	Bn, T Super	1.44	------	2.63	----------	4.07	------	2.26	------	0.84
----	*6.00*	*4.00*	*10.00*		*1.00*	------	*3.00*	Bl, Bn, T, G	*4.00*	------	*2.00*	------	----
701	8.23	3.37	11.60	Bn, T Super	0.97	------	2.30	----------	3.27	------	3.13	------	----
----	*7.50*	*4.50*	*12.00*		------	------	*2.50*	Bl, Bn, T	*2.50*	------	*3.00*	------	----
788	6.69	5.19	11.88	------	1.85	------	1.94	----------	3.79	------	**3.82**	------	1.24
----	*4.00*	*9.00*	*13.00*	Bn	------	------	*4.00*	Bl, Bn	*4.00*	------	*5.00*	------	----
588	9.31	1.11	10.42	Bn, T Super	------	------	3.43	----------	3.43	------	2.47	------	----
----	*9.00*	*1.00*	*10.00*		------	------	*3.30*	Bl, Bn, T	*3.30*	------	*2.00*	------	----
640	7.80	3.06	10.86	Bn, T Super	1.22	------	2.48	----------	3.70	------	3.49	------	0.60
----	*6.00*	*4.00*	*10.00*		*1.00*	------	*2.00*	Bl, Bn, T	*3.00*	------	*3.00*	------	----
625	10.11	1.21	11.32	------	1.16	------	1.91	----------	3.07	------	4.09	------	0.70
699	5.86	2.02	7.88	Bn, T Super	1.49	------	1.81	----------	3.30	------	5.64	------	----
----	*6.00*	*2.00*	*8.00*		*1.00*	------	*2.00*	Bl, Bn, T	*3.00*	------	*4.00*	------	----
641	7.33	5.29	12.62	Bn, T Super	0.80	------	2.91	----------	**3.71**	------	3.28	------	0.60
----	*5.00*	*5.00*	*10.00*		*3.00*	------	*1.00*	Bl, Bn, T	*4.00*	------	*3.00*	------	----
642	5.91	4.55	10.46	------	0.47	------	3.23	----------	**3.70**	------	2.95	------	----
700	7.05	3.18	10.23	Bn, T Super	1.18	------	2.65	----------	3.83	------	3.63	------	----
----	*5.00*	*5.00*	*10.00*		*1.00*	------	*3.00*	Bl, Bn, T	*4.00*	------	*3.00*	------	----
583	------	------	------	----	------	------	------	----------	------	------	**48.96**	------	1.96
----	------	------	------	------	----	------	------	----------	------	------	*50.00*	------	----
653	22.42	0.80	23.22	------	----	------	------	----------	------	------	------	------	----
----	*16.00*	------	------	------	----	------	------	----------	------	----	------	------	----
626	7.25	2.14	9.39	------	2.27	0.14	0.65	----------	3.06	------	5.15	------	0.60
----	*7.00*	*1.00*	*8.00*		*2.25*	----	*0.65*	----------	*2.90*	------	*5.00*	------	----
643	8.62	2.60	11.22	------	2.75	0.13	0.98	----------	3.86	------	1.47	------	----
645	9.07	1.39	10.46	------	2.64	0.25	1.11	----------	**4.00**	------	1.78	----	----
----	*9.00*	*1.00*	*10.00*	------	*2.50*	*0.30*	*1.30*	----------	*4.10*	------	*1.50*	------	----

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	American Agricultural Chemical Co., Los Angeles, Cal.—Continued.		
599	Bradley's Nursery Stock	Geo. S. Gay, Craftonville	27.49
627	do	Mrs. M. E. Wallace, Rialto	27.40
644	do	S. H. Barrett, East Highlands	28.67
646	do	Graham-Cope Com'cial Co., Redlands	28.22
702	do	Pacific Wood and Coal Co., San Diego	27.11
703	do	W. R. Powell, Glendora	27.06
704	do	W. L. Hale, Fullerton	27.45
706	do	W. A. Johnstone, San Dimas	28.10
707	do	E. C. Robinson, Pomona	28.14
	Guaranteed		*27.11*
705	Bradley's Nursery Stock	R. H. Hill, Fernando	28.60
708	do	J. F. Munro, Upland	28.36
	Guaranteed		*27.17*
628	Bradley's Orange and Lemon	Mrs. M. E. Wallace, Rialto	28.41
647	do	Graham-Cope Com'cial Co., Redlands	28.26
709	do	Pacific Wood and Coal Co., San Diego	27.07
710	do	W. R. Powell, Glendora	28.58
711	do	W. W. Blanchard, Santa Paula	28.48
	Guaranteed		*26.20*
712	Bradley's Orange and Lemon	J. F. Munro, Upland	27.39
	Guaranteed		*26.42*
665	Nitrate of Soda	Pacific Wood and Coal Co., San Diego	52.00
	Guaranteed		*52.14*
	Armour Fertilizer Works, Los Angeles, Cal.		
579	Armour's Dried Blood	Factory, Colton	51.02
612	do	Fitz, Gerald and Barry, Pasadena	47.92
	Guaranteed		*48.10*
655	Armour's Dried Blood	J. W. Freeman, Redlands	52.35
	Guaranteed		*51.80*
713	Armour's Bone, Blood, and Potash	F. L. Palmer, North Pomona	33.12
714	do	G. W. Russell, Ontario	34.18
715	do	Factory, Colton	34.81
	Guaranteed		*32.95*
791	Armour's Bone, Blood, and Potash	T. E. Ketcheson, Upland	33.36
	Guaranteed		*32.80*
694*	Armour's Bone Floats	W. H. Brown, Los Angeles	29.02
	Guaranteed		*27.70*
566*	Armour's Bone Meal	Arlington H'ghts Fruit Co., Riverside	29.97
567*	do	Arlington H'ghts Fruit Co., Riverside	29.68
568*	do	Arlington H'ghts Fruit Co., Riverside	29.82
577*	do	Arlington H'ghts Fruit Co., Riverside	29.45
	Guaranteed		*28.31*
589*	Armour's Bone Meal	J. W. Freeman, Redlands	29.83
629*	do	J. C. Boyd, Rialto	29.90
	Guaranteed		*27.70*
613*	Armour's Bone Meal	Fitz, Gerald and Barry, Pasadena	30.62
690*	do	G. W. Russell, Ontario	29.43
	Guaranteed		*27.80*
691*	Armour's Bone Meal	Blake Bros., Pasadena	30.14
	Guaranteed		*24.50*
692*	Armour's Bone Meal	J. W. Freeman, Redlands	32.01
	Guaranteed		*32.00*
693*	Armour's Bone Meal	W. H. Brown, Los Angeles	30.32
	Guaranteed		*26.20*

*694—98 per cent fine.
*566—66 per cent fine.
*567—67 per cent fine.
*577—67 per cent fine.
*589—70 per cent fine.
*629—67 per cent fine.
*690—58 per cent fine.
*691—60 per cent fine.
*692—66 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Pounds Per Hundred.

Laboratory Number	Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates.	In Ammonia Salts.	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
599	9.38	1.34	10.72	All samples of complete fertilizer of this company bone and acid phosphate.	2.93	0.08	1.04	All samples of complete fertilizer of this company Bl, Bn, T, Bat G, Fs	4.05	------	1.56	------	----
627	9.40	1.52	10.92		2.82	0.32	1.07		4.21	------	1.72	------	0.54
644	9.44	1.29	10.73		2.76	0.30	1.16		4.22	------	1.95	------	----
646	9.33	1.39	10.72		2.71	0.31	1.14		4.16	------	1.81	------	----
702	9.21	1.43	10.64		2.43	0.33	1.06		**3.82**	------	1.93	------	----
703	9.29	1.75	11.04		2.51	0.39	0.85		**3.75**	------	1.91	------	----
704	9.45	1.42	10.87		2.63	0.32	0.91		3.86	------	1.91	------	----
706	9.33	1.35	10.68		2.67	0.24	1.21		4.12	------	1.83	------	----
707	9.57	1.43	11.00		2.73	0.29	0.97		3.99	------	1.99	------	----
----	*9.00*	*1.00*	*10.00*		*2.50*	*0.30*	*1.30*		*4.10*	------	*1.50*	------	----
705	9.35	0.88	10.23		2.28	0.33	1.56		4.17	------	2.18	------	----
708	9.04	1.07	10.11		2.52	0.35	1.41		4.28	------	1.93	------	----
----	*9.00*	*1.00*	*10.00*		*2.30*	*0.40*	*1.40*		*4.10*	------	*1.50*	------	----
628	10.31	0.40	10.71		2.68	------	0.85		3.53	------	3.28	------	0.52
647	9.52	1.22	10.74		2.84	------	0.84		3.68	------	3.20	------	----
709	8.86	1.22	10.08		2.43	------	1.31		3.74	------	2.57	------	----
710	8.92	1.70	10.62		3.08	------	0.82		3.90	------	3.26	------	----
711	9.77	0.97	10.74		2.87	------	0.80		3.67	------	3.26	------	----
----	*8.00*	*1.00*	*9.00*		*2.75*	------	*0.95*		*3.70*	----	*3.00*	------	----
732	8.44	1.56	10.00		2.43	0.31	0.94		3.68	------	3.30	------	----
----	*8.00*	*1.00*	*9.00*		*2.00*	*0.40*	*1.30*		*3.70*	------	*3.00*	------	----
665	------	------	------		15.76	------	-----		15.76	------	------	------	----
----	------	------	------		*15.80*	------	------		*15.80*	------	------	------	----
579	------	------	------	------	------	------	13.79	------	13.79	------	------	------	----
612	------	------	------	------	------	------	12.95	------	12.95	------	------	------	----
----	------	------	------	------	------	------	*13.00*	------	*13.00*	------	------	------	----
655	------	------	------	------	------	------	14.15	------	14.15	------	------	------	----
----	------	------	------	------	------	------	*14.00*	------	*14.00*	------	------	------	----
713	8.96	1.40	10.36	------	1.75	------	2.24	------	3.99	------	6.52	------	0.62
714	9.37	0.85	10.22	------	1.89	------	2.07	------	3.96	------	7.35	------	0.54
715	8.96	0.69	9.65	------	1.87	------	2.34	------	4.21	------	7.60	------	0.58
----	*8.00*	*2.00*	*10.00*	------	*1.50*	------	*2.50*	------	*4.00*	------	*7.00*	------	----
791	8.63	0.87	9.50	------	2.22	------	2.08	------	4.30	------	**6.45**	------	----
----	*8.00*	*2.00*	*10.00*	------	*2.00*	------	*2.00*	------	*4.00*	------	*7.00*	------	----
694	------	------	24.58	------	------	------	2.87	------	2.87	------	------	------	----
----	------	------	*24.00*	------	------	------	*2.50*	------	*2.50*	------	------	------	----
566	------	------	21.95	------	------	------	3.65	------	3.65	------	------	------	----
567	------	------	21.97	------	------	------	3.56	------	3.56	------	------	------	----
568	------	------	**20.82**	------	------	------	3.87	------	3.87	------	------	------	----
577	------	------	22.15	------	------	------	3.45	------	3.45	------	------	------	----
----	------	------	*22.00*	------	------	------	*3.15*	------	*3.15*	------	------	------	----
589	------	------	23.27	------	------	------	3.30	------	3.30	------	------	------	----
629	------	------	23.40	------	------	------	3.29	------	3.29	------	------	------	----
----	------	------	*24.00*	------	------	------	*2.50*	------	*2.50*	------	------	------	----
623	------	------	21.41	------	------	------	3.97	------	3.97	------	------	------	----
690	------	------	24.37	------	------	------	2.92	------	2.92	------	------	------	----
----	------	------	*22.00*	------	------	------	*3.00*	------	*3.00*	------	------	------	----
691	------	------	25.01	------	------	------	2.98	------	2.98	------	------	------	----
----	------	------	*20.00*	------	------	------	*2.50*	------	*2.50*	------	------	------	----
692	------	------	22.71	------	------	------	4.07	------	4.07	------	------	------	----
----	------	------	*23.00*	------	------	------	*4.00*	------	*4.00*	------	------	------	----
693	------	------	22.94	------	------	------	3.52	------	3.52	------	------	------	----
----	------	------	*20.00*	------	------	------	*3.00*	------	*3.00*	------	------	------	----

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Armour Fertilizer Works, Los Angeles, Cal.—Continued.		
716	Armour's Spcl. Flower and Fern Food	W. H. Brown, Los Angeles	30.34
	Guaranteed		*31.78*
717	Armour's Fruit Special	Griffin & Skelley, Fresno	23.74
	Guaranteed		*21.87*
718	Armour's Lawn and Garden	R. T. Murrell, North Pomona	24.96
719	do	W. H. Brown, Los Angeles	25.41
720	do	Blake Bros., Pasadena	23.66
	Guaranteed		*24.05*
590	Armour's Nitrate of Soda	J. W. Freeman, Redlands	51.87
666	do	J. W. Freeman, Redlands	51.35
667	do	A. M. Seely, Covina	51.29
668	do	R. T. Murrell, North Pomona	51.35
	Guaranteed		*49.50*
593	Armour's Orange Tree Manure	Manufacturers, Colton	27.76
594	do	J. W. Freeman, Redlands	27.78
630	do	J. C. Boyd, Rialto	29.13
721	do	R. T. Murrell, North Pomona	27.73
722	do	G. W. Russell, Ontario	27.78
	Guaranteed		*25.75*
631	Armour's Pea Special	J. C. Boyd, Rialto	32.25
723	do	A. M. Seely, Covina	29.67
724	do	G. W. Russell, Ontario	26.79
	Guaranteed		*25.10*
603	Armour's Special 5-8-2	Geo. S. Gay, Craftonville	28.25
615	do	J. W. Henderson, Claremont	28.08
618	do	Factory, Colton	27.59
636	do	Ernest Richter, San Dimas	28.76
725	do	J. S. Edwards, East Highlands	29.19
727	do	J. W. Freeman, Redlands	28.16
728	do	A. M. Seely, Covina	27.18
	Guaranteed		*26.95*
726	Armour's Special 5-8-2	J. S. Edwards, East Highlands	28.93
	Guaranteed		*27.40*
582	Armour's Special Fertilizer	James M. Riley, Covina	33.13
	Guaranteed		*30.50*
619	Armour's Special	Factory, Colton	38.40
	Guaranteed		*40.36*
600	Sulfate of Potash	Arlington H'ghts Fruit Co., Riverside	57.94
	Guaranteed		*58 04*
614	Armour's Sulfate of Potash	Fitz, Gerald and Barry, Pasadena	58.13
	Guaranteed		*57.60*
656	Armour's Sulfate of Potash	J. W. Freeman, Redlands	**58.75**
	Guaranteed		*60.00*
552*	Armour's Tankage	Arlington H'ghts Fruit Co., Riverside	31.51
553*	do	Arlington H'ghts Fruit Co., Riverside	31.71
554*	do	Arlington H'ghts Fruit Co., Riverside	32.39
555*	do	Arlington H'ghts Fruit Co., Riverside	32.78
556*	do	Arlington H'ghts Fruit Co, Riverside	33.73
569*	do	Arlington H'ghts Fruit Co., Riverside	32.54
578*	do	Arlington H'ghts Fruit Co., Riverside	31.71
	Guaranteed		*30.90*
620*	Armour's Tankage	Factory, Colton	32.47
	Guaranteed		*30.80*

*552—84 per cent fine.
*553—76 per cent fine.
*554—77 per cent fine.
*555—79 per cent fine.
*556—77 per cent fine.
*569—75 per cent fine.
*578—78 per cent fine.
*620—70 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds Per Hundred. Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
716	8.07	1.19	9.29	Bn, G. Super	1.68		3.06		**4.74**		2.91		
	8.00	*2.00*	*10.00*		*1.40*		*3.60*	Bn, G.	*5.00*		*3.00*		
717	9.11	1.84	10.95	Bn, T Super	0.92		0.69		1.61		5.31		
	8.00	*2.00*	*10.00*		*0.50*		*1.00*	Bl, Bn, T	*1.50*		*5.00*		
718	5.00	1.57	6.57		1.35		2.44		3.79		4.11		
719	6.29	1.11	7.40		1.66		2.12		3.78		**3.49**		
720	5.29	0.41	5.70	Bn, G, T Super	1.50		2.00		**3.50**		4.13		
	4.00	*1.00*	*5.00*		*1.50*		*2.50*	Bl, Bn, G, T	*4.00*		*4.00*		
590					15.72								0.56
666					15.56								
667					15.54								
668					15.56								
					15.00								
593	9.07	2.30	11.37		1.66	0.24	1.10		3.00		4.52		
594	9.62	2.00	11.62		1.53	0.24	1.13		2.90		4.38		
630	10.68	1.12	11.80		1.80		1.15		2.95		4.73		
721	9.93	1.20	11.13		1.66		1.23		2.89		4.42		
722	9.49	1.10	10.59	Bn, G, T Super	1.72		1.24		2.96		4.75		
	8.00	*2.00*	*10.00*		*1.50*		*1.50*	Bl, Bn, G, T	*3.00*		*4.00*		
631	12.86	3.27	16.13				3.07		3 07		3.44		0.58
723	13.25	2.41	15.66				2.64		2.64		2.55		
724	10 60	4.62	15.22	Bn. T Super			2.50		2.50		2.30		
	8.00	*7.00*	*15.00*				*2.50*	Bl, Bn, T	*2.50*		*2.50*		
603	9.40	1.57	10.97		1.62		2.25		3.87		2.28		
615	9.00	1.54	10.54		1.60		2.34		3.94		2.34		
618	7.74	3.34	11.08		1.63		2.29		3.92		2.51		0.62
636	8.54	1.77	10.31		1.52		2.64		4.16		2.59		0.60
725	10.21	1.03	11.24		1.87		2.05		3.92		2.39		
727	9.06	0.83	9.89		1.99		2.23		4.22		1.89		
728	9.30	0.91	10.21	Bn, G, T Super	1.60		2.17		3.77		2.05		
	8.00	*2.00*	*10.00*		*1.50*		*2.50*	Bl, Bn, G. T	*4.00*		*2.00*		
726	9.02	1.31	10.33				4.12		4.12		2.18		
	8.00	*2.00*	*10.00*				*4.00*		*4.00*		*2.00*		
582	15.41	4.51	19.92				1.57		1.57		5.61		0 54
	12.00	*7.00*	*19.00*	Bn, Super			*1.50*	Bn	*1.50*		*6.00*		
619			11.27				5.03		**5.03**		9.40		0 64
			11.00	Bn			*5.50*	Bl, Bn	*5.50*		*9.80*		
600											48.28		2.68
614											*48.67*		
											48.44		2.02
656											*48.00*		
											48.96		
552			11.89				6.47		6.47		*50.00*		
553			11.34				6.66		6.66				
554			12.26				6.64		6.64				
555			13.10				6.56		6.56				
556			11.48				7.22		7.22				
577			11.60				6.84		6.84				
578			11.97				6.51		6.51				
			11.00				*6.50*		*6.50*				
620			12.50				6.61		6.61				0.56
			13.00				*6.00*		*6.00*				

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Armour Fertilizer Works, Los Angeles, Cal.—Continued.		
621*	Armour's Tankage	J. W. Freeman, Redlands	32.85
	Guaranteed		*29.00*
632*	Armour's Tankage	J. C. Boyd, Rialto	27.10
688*	do	J. S. Edwards, East Highlands	27.21
	Guaranteed		*26.50*
689*	Armour's Tankage	F. L. Palmer, North Pomona	29.90
	Guaranteed		*29.30*
	Balfour, Guthrie & Co., San Francisco, Cal.		
669	Nitrate of Soda	Balfour, Guthrie & Co., San Francisco	51.61
670	do	M. Braughler, Santa Rosa	51.28
671	do	Thos. G. Aitken, Reedley	52.07
	Guaranteed		*49.50*
684	Sulfate of Potash	Balfour, Guthrie & Co., San Francisco	57.45
685	do	M. Braughler, Santa Rosa	59.14
	Guaranteed		*57.60*
686	Sulfate of Potash	Beckman, Welch & Co., Lodi	59.76
	Guaranteed		*58.36*
673*	Thomas Phosphate Powder	Balfour, Guthrie & Co., San Francisco	17.30
674*	do	M. Braughler, Santa Rosa	17.66
676*	do	Thos. G. Aitken, Reedley	17.57
677*	do	G. W. Sill, Watsonville	17.64
	Guaranteed		*17.61*
678*	Thomas Phosphate Powder	N. W. Blanchard, Santa Paula	17.75
	Guaranteed		*17.31*
675*	Thomas Phosphate Powder	Beckman, Welch & Co., Lodi	15.17
	Guaranteed		*15.75*
	California Fertilizer Works, San Francisco, Cal.		
580	H. G. Special Ammoniated Bone Superphosphate	J. D. Farwell, Los Gatos	33.60
	Guaranteed		*28.28*
729	Fruit and Vine	Sam Meyer, Healdsburg	31.36
732	do	San Monte Fruit Co., Watsonville	30.20
	Guaranteed		*26.13*
730	Fruit and Vine	Pioneer Fruit Co., New Castle	30.43
731	do	Fresno Home Packing Co., Fresno	30.78
	Guaranteed		*26.48*
565	Special Fruit and Vine	G. W. Wyllie, Dinuba	27.74
	Guaranteed		*24.86*
584	Fruit, Orange, and Vine	C. W. Flanders, Porterville	27.94
733	do	Manufacturers, San Francisco	27.78
734	do	A. G. Schultz, Porterville	28.53
	Guaranteed		*26.20*
735	Nursery Stock	Pioneer Fruit Co., New Castle	29.47
736	do	San Monte Fruit Co., Watsonville	26.45
	Guaranteed		*26.40*
737	Odorless Lawn Dressing	Cox Seed Co., San Francisco	31.10
752	do	Sam Meyer, Healdsburg	29.82
	Guaranteed		*20.69*

*621—67 per cent fine.
*632—73 per cent fine.
*688—78 per cent fine.
*689—80 per cent fine.
*673—73 per cent fine.
*674—69 per cent fine.
*675—79 per cent fine.
*676—74 per cent fine.
*677—76 per cent fine.
*678—78 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
621			14.16				6.33		6.33				
			15.00				*5.00*		*5.00*				
632			13.56				4.78		4.78				
688			**12.76**				5.00		5.00				
			14.00				*4.50*		*4.50*				
689			10.26				6.38		6.38				
			9.00				*6.50*		*6.50*				
669					15.64								
670					15.54								
671					15.78								
					15.00								
684											47.88		1.00
685											49.28		
											48.60		
686											49.80		
											48.60		
673			19.22										
674			19.62										
676			19.52										
677			19.60										
			19.57										
678			19.72										
			19.23										
675			16.86										
			17.50										
580	13.03	5.56	18.59				4.22		4.22				
	12.00	*4.00*	*16.00*				*3.30*		*3.30*				
729	8.24	2.32	10.56		0.73	0.76	1.44		2.93		8.32		
732	8.65	2.64	11.29	Bn. T. Super	0.87	0.65	1.32		2.84		7.12		0.70
	6.00	*3.00*	*9.00*		*0.50*		*2.00*	Bl, Bn, T	*2.50*		*7.15*		
730	9.08	1.71	10.79		0.67	0.67	1.19		2.53		8.14		
731	7.61	2.53	10.14	Bn. T. Super	0.66	0.66	1.55		2.87		8.53		0.76
	6.50	*2.50*	*9.00*		*0.50*		*2.00*	Bl, Bn, T	*2.50*		*7.15*		
565	7.07	4.62	11.69		0.92	0.80	1.61		3.33		4.36		
	7.00	*3.00*	*10.00*	Bn. T. Super	*0.35*		*2.50*	Bl, Bn, T	*2.85*		*4.00*		
584	5.91	3.43	9.34		0.60	0.57	1.50		2.67		8.09		1.02
733	6.70	2.77	9.47		0.70	0.59	1.21		2.50		7.97		
734	6.69	2.32	9.01		0.85	0.52	1.27		2.64		8.41		
	6.00	*3.50*	*9.50*	Bn. T. Super	*0.50*		*2.00*	Bl, Bn, T	*2.50*		*7.00*		
735	9.21	4.35	13.56		1.16	0.78	1.83		3.77		2.51		
736	7.80	3.05	10.85		1.34	0.62	1.43		**3.39**		3.13		
	7.00	*3.00*	*10.00*	Bn. T. Super	*1.00*		*3.00*	Bl, Bn, T	*4.00*		*2.00*		
737	11.11	4.61	15.72		3.59				3.59		3.01		
752	8.28	4.11	12.39		3.52				3.52		5.17		
			10.00	Super	*3.30*				*3.30*		*1.50*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	California Fertilizer Works, San Francisco—Continued.		
738	Orange Tree	William Calder, Folsom	28.84
	Guaranteed		*26.08*
596	Orange Tree, B	J. H. Williams, Porterville	32.41
	Guaranteed		*27.34*
739	Special Orange Tree	W. J. Benjamin, Riverside	33.55
	Guaranteed		*29.38*
740	Peach	Pioneer Fruit Co., New Castle	31.02
741	do	San Monte Fruit Co., Watsonville	29.35
	Guaranteed		*24.68*
651	Special Phosphate and Potash	Judson House, Riverside	29.45
	Guaranteed		*29.45*
742	Special Phosphate and Potash	R. Wilson, Los Gatos	24.87
597	do	J. H. Williams, Porterville	25.40
	Guaranteed		*22.60*
595	Special High Grade	W. E. Sprott, Porterville	31.69
	Guaranteed		*29.05*
790	Special	Hearst Estate, Palermo	28.33
	Guaranteed		*27.40*
616	Truck and Berry	E. L. Smith, Yuba City	29.08
743	do	R. N. Kells, Yuba City	28.61
744	do	San Monte Fruit Co., Watsonville	28.44
	Guaranteed		*24.75*
	Cudahy Packing Co., So. Omaha, Neb.		
557*	Cudahy's Blood and Bone	Arlington H'ghts Fruit Co., Riverside	27.96
558*	do	Arlington H'ghts Fruit Co., Riverside	29.39
576*	do	Arlington H'ghts Fruit Co., Riverside	28.88
	Guaranteed		*27.90*
601*	Tankage	Arlington H'ghts Fruit Co., Riverside	29.82
602*	do	Arlington H'ghts Fruit Co., Riverside	30.01
	Guaranteed		*29.23*
	R. A. Holcombe & Co., San Francisco, Cal.		
672	Nitrate of Soda	R. A. Holcombe & Co., San Francisco	**50.16**
	Guaranteed		*51.65*
	Maier Fertilizer Co., Los Angeles, Cal.		
654	"A. A."	G. W. Joslin, North Pomona	29.40
661	do	A. Ingram, Pomona	**29.25**
	Guaranteed		*32.00*
657	"A. A."	Levi Bemis, Rialto	31.41
	Guaranteed		*31.30*
695*	"T"	Levi Bemis, Rialto	26.09
	Guaranteed		*22.80*
	Mapes Formula and P. G. Co., New York.		
745	Mapes Orange Tree Manure	J. J. Prendergast, Redlands	23.89
	Guaranteed		*22.92*

*557—84 per cent fine. *576—80 per cent fine. *602—83 per cent fine.
*558—86 per cent fine. *601—81 per cent fine. *695—72 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Pounds per Hundred.

Laboratory Number	Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates.	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
738	7.12	1.44	8.56	Bn, T, Super	1.82	0.36	0.97	Bl, Bn, T	3.15		7.31		
	5.00	*2.00*	*7.00*				*3.30*		*3.30*		*6.00*		
596	8.52	3.37	11.89			1.35	0.75		2.10		10.79		0.62
	7.00	*2.00*	*9.00*			*0.85*	*0.85*		*1.65*		*10.00*		
739	10.23	3.50	13.73		0.98	0.58	1.34		2.90		7.82		
	8.00	*2.50*	*10.50*		*0.85*		*2.00*		*2.85*		*7.10*		
740	8.59	2.40	10.99		0.69	0.62	1.17		2.48		8.99		
741	6.26	2.49	8.75		0.96	0.61	1.12		2.69		9.32		
	6.00	*2.50*	*8.50*		*0.50*		*2.00*		*2.50*		*7.25*		
651	14.32	4.06	18.38								**8.53**		
	13.50	*2.50*	*16.00*								*10.00*		
742	9.59	3.66	13.25								9.61		
597	9.05	2.31	11.36						0.20		10.56		
	8.00	*2.00*	*10.00*								*10.00*		
595	6.35	2.19	8.54	Bn, T, Super	0.65	0.58	1.18	Bl, Bn, T	2.41		12.07		0.68
	6.00	*2.00*	*8.00*		*0.50*		*2.00*		*2.50*		*10.00*		
790	11.30	2.90	14.20				3.70		**3.70**		0.79		
	10.00	*2.00*	*12.00*				*4.00*		*4.00*				
616	9.92	2.02	11.94		0.66	0.87	1.34		2.87		5.06		0.82
743	8.70	3.50	12.20		0.78	0.86	1.27		2.91		5.15		0.90
744	8.22	2.55	10.77		0.85	0.67	1.16		2.68		6.58		0.70
	7.00	*3.00*	*10.00*		*0.50*	*2.00*			*2.50*		*5.00*		
557	**4.58**	9.35	13.93				5.23		5.23				0.74
558	**3.74**	8.04	11.78				6.14		6.14				0.70
576	**5.47**	6.95	12.42				5.54		5.54				
	7.00	*5.00*	*12.00*				*5.00*		*5.00*				
601			14.66				5.32		5.32				
602			15.08				5.28		5.28				
			13.80				*5.35*		*5.35*				
672					**15.20**								
					15.65								
654	11.87	3.42	15.29				3.56		**3.56**		**0.52**		
661	10.94	4.18	15.12				3.75		**3.75**		**0.44**		
	8.00	*4.00*	*12.00*	Bn, T			*5.00*	Bl, Bn, T	*5.00*		*2.00*		
657	8.76	4.49	13.25				4.80		4.80		**1.14**		
	7.00	*5.00*	*12.00*	Bn, T			*5.00*	Bl, Bn, T	*5.00*		*2.00*		
695	6.77	7.32	14.09				4.21		4.21				
	8.00	*6.00*	*14.00*	Bn, T			*3.00*	Bl, Bn, T	*3.00*				
745	6.72	2.13	8.85		1.91	0.43	0.86		3.20		3.18		1.70
	6.00	*2.00*	*8.00*	Bn, G	*2.40*	*0.15*	*0.74*	G, Bn	*3.29*		*3.00*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	S. M. Neely, San Diego.		
746	Bird Guano	S. M. Neeley	26.01
	Guaranteed		*38.17*
	Nelson, Morris & Co., Chicago.		
559*	Big Two	Arlington H'ghts Fruit Co., Riverside	32.32
	Guaranteed		*29.44*
696*	Big Two	L. G. Haight, Redlands	30.52
	Guaranteed		*30.90*
747*	Big Three	L. G. Haight, Redlands	23.36
	Guaranteed		*18.90*
748*	Big Four	Wilcox, Rose Co., Colton	34.20
	Guaranteed		*28.85*
749	Big Five	Wilcox, Rose Co., Colton	21.34
	Guaranteed		*17.70*
750*	Big Six	Wilcox, Rose Co., Colton	25.44
	Guaranteed		*25.75*
793*	Big Eight	C. H. Lowe, Riverside	32.87
	Guaranteed		*30.00*
570	Dried Blood	Arlington H'ghts Fruit Co., Riverside	47.88
617	do	L. S. Flateau, Redlands	**46.92**
	Guaranteed		*48.10*
652*	Steamed Bone Meal	C. H. Lowe, Riverside	33.82
	Guaranteed		*30.00*
571*	Tankage	T. C. Wallace, Riverside	34.34
564*	do	W. W. Moore, Redlands	33.59
581*	do	W. W. Moore, Redlands	34.17
622*	do	Ed Roberts, Colton	**30.96**
	Guaranteed		*33.30*
585*	Tankage	Arlington H'ghts Fruit Co., Riverside	33.13
	Guaranteed		*33.30*
658*	Tankage	Mrs. B. K. Fox, Pomona	36.70
660*	do	Thos. C. Wallace, Riverside	36.48
	Guaranteed		*37.55*
659*	Tankage	C. L. Merryfield, Colton	32.76
	Guaranteed		*30.70*
	Oakland Meat Co., Stock Yards, Cal.		
697*	Special Fertilizer	Manufacturers	32.07
	Guaranteed		*30.00*
	Pacific Bone, Coal and Fertilizer Co., San Francisco, Cal.		
773*	Pure Bone Meal	Cox Seed & Plant Co., San Francisco	29.35
	Guaranteed		*26.95*
756	Special	Schnabel Bros., New Castle	33.23
	Guaranteed		*29.78*
751	Ceres	E. L. Rippey, Loomis	30.89
	Guaranteed		*25.35*

*559—67 per cent fine. Small amount of hoof.
*696—65 per cent fine.
*747—51 per cent fine.
*748—60 per cent fine. Contains considerable hoof.
*793—75 per cent fine.
*652—69 per cent fine.
*571—90 per cent fine.
*564—86 per cent fine.
*581—91 per cent fine.
*622—89 per cent fine.
*585—85 per cent fine.
*750—81 per cent fine.
*658—62 per cent fine. Contains considerable hoof.
*660—65 per cent fine. Contains considerable hoof.
*659—63 per cent fine. Contains considerable hoof.
*697—75 per cent fine.
*773—53 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
746	**7.07**	0.73	7.80		0.51	1.98	1.94		**4.43**		**1.14**		1.18
	8.86	*1.10*	*9.96*		*0.63*	*1.67*	*4.67*		*6.97*		*1.74*		
559			**25.52**				3.50		3.50				
			28.00				*2.06*		*2.06*				
696			27.28				2.56		2.56				
			28.00				*2.50*		*2.50*				
747			11.36				2.98		2.98		3.45		
			10.00				*2.50*		*2.50*		*2.00*		
748			12.74				4.95		4.95		5.98		
			12.00				*4.25*		*4.25*		*4.00*		
749			11.24				3.20		3.20		1.22		
			10.00				*2.50*		*2.50*		*1.00*		
750			**25.98**				1.37		1.37				
			29.00				*0.75*		*0.75*				
793			25.70				2.51		2.51		**3.15**		
			23.00				*2.00*		*2.00*		*4.00*		
570							12.94		12.94				
617							12.68		**12.68**				
652			23.32				*13.00*		*13.00*				
			23.00				3.45		3.45		**2.86**		
571			17.46				*2.00*		*2.00*		*4.00*		
564			16.82				5.99		**5.99**				
581			17.76				5.92		**5.92**				
622			13.93				5.87		**5.87**				
			14.00				5.83		**5.83**				
585			**11.57**				*6.50*		*6.50*				
			13.74				7.02		.02				
658			7.25				*6.58*		*6.58*				
660			7.39				9.09		**9.09**				
			5.50				8.99		**8.99**				
659			5.89				*9.75*		*9.75*				
			5.50				8.25		**8.25**				
							9.50		*9.50*				
697			14.62				5.99		5.99				
			12.00	Bn, T			*6.00*	Bl, Bn, T	*6.00*				
773			23.55				3.09		3.09				
			22.00				*2.75*		*2.75*				
756	8.28	0.10	8.38		3.73				3.73		9.11		0.90
	7.00			Bn, Super	*3.75*			Bn	*3.75*		*7.50*		
751	11.16	0.66	11.82		2.13		0.93		3.06		5.66		
	7.00	*3.00*	*10.00*		*1.50*		*1.25*		*2.75*		*5.00*		

All Bone Meals or Tankages.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Pacific Bone, Coal, and Fertilizer Co., San Francisco, Cal.—Continued.		
754	Lupine	Schnabel Bros., Newcastle	24.35
	Guaranteed		*23.30*
753	Pomona	Schnabel Bros., Newcastle	32.55
755	do	A. Ryder, Loomis	34.38
	Guaranteed		*29.65*
	Swift & Co., Chicago.		
560	Swift's Dried Blood	Arlington H'gts Fruit Co., Riverside	53.28
561	do	Arlington H'gts Fruit Co., Riverside	52.84
562	do	Arlington H'gts Fruit Co., Riverside	53.47
563	do	Arlington H'gts Fruit Co., Riverside	53.28
	Guaranteed		*51.80*
574	Dried Blood	Wm. Buxton, Rialto	50.95
681	do	E. L. Koethen, Riverside	50.14
682	do	Geo. Griffiths, Covina	49.50
	Guaranteed		*48.10*
572*	Special Bone Meal	Wm. Buxton, Rialto	29.66
587*	do	Geo. H. Engelhard, Los Angeles	29.93
605*	do	C. W. La Ferta, Glendora	28.59
774*	do	E. L. Koethen, Riverside	29.81
775*	do	Geo. Griffiths, Covina	30.17
	Guaranteed		*25.99*
776	Swift's Diamond B	H. E. Bartlett, Upland	31.07
	Guaranteed		*29.09*
777*	Swift's Diamond C	H. E. Bartlett, Upland	30.12
	Guaranteed		*28.40*
573*	Diamond E	A. A. Cox, San Bernardino	31.14
575*	do	Wm. Buxton, Rialto	31.57
586	do	Clock Bros., Redlands	31.70
606*	do	W. P. Hill, Glendora	30.52
778*	do	Carroll B. Smith, Redlands	32.21
779*	do	E. L. Koethen, Riverside	32.24
780*	do	E. L. Koethen, Riverside	30.91
781*	do	Carroll B. Smith, Redlands	30.94
	Guaranteed		*32.00*
607	Diamond G	J. P. Engelhard, Glendora	33.35
757*	do	H. E. Bartlett, Upland	32.61
758*	do	E. L. Koethen, Riverside	34.19
	Guaranteed		*32.90*
604*	Special for L. P. Stewart, *et al.*	Carroll B. Smith, Redlands	37.27
	Guaranteed		*38.74*
679*	Thomas Phosphate Powder	Carroll B. Smith, Redlands	17.82
	Guaranteed		*17.31*
	Union Fertilizer Company, Los Angeles, Cal.		
683	Dried Blood	E. E. Cole, Redlands	47.06
	Guaranteed		*44.40*
782*	Bone Meal	J. W. Freeman, Upland	28.80
783*	do	C. A. Miller, Highlands	30.56
	Guaranteed		*26.10*

*572—60 per cent fine.
*587—62 per cent fine.
*605—55 per cent fine.
*774—54 per cent fine.
*775—62 per cent fine.
*777—58 per cent fine.
*573—78 per cent fine.
*575—77 per cent fine.
*606—80 per cent fine.
*778—89 per cent fine.
*779—85 per cent fine.
*780—71 per cent fine.
*781—79 per cent fine.
*757—80 per cent fine.
*758—77 per cent fine.
*604—76 per cent fine.
*679—77 per cent fine.
*782—24 per cent fine.
*783—38 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
754	11.10	0.05	11.15										
	9.00	*1.00*	*10.00*								9.17		
753	8.33	0.18	8.51		1.46	0.74	0.66				*10.00*		
755	9.46	1.31	10.77		1.87		1.22		2.86		10.50		
	6.00	*2.00*	*8.00*	Bn, T Super	*1.50*		*1.25*	Bl, Bn, T	3.09		9.84		
									2.75		*10.00*		
560							14.40		14.40				
561							14.28		14.28				
562							14.45		14.45				
563							14.40		14.40				
							14.00		*14.00*				
574							13.77		13.77				
681							13.55		13.55				
682							13.38		13.38				
							13.00		*13.00*				
572			30.24				1.61		1.61				
587			29.12				1.95		1.95				
605			28.18				1.78		1.78				
774			28.04				2.17		2.17				
775			29.42				1.95		1.95				
			29.00				*0.82*		*0.82*				
776	15.03	5.69	20.72				2.83		2.83				
	16.00	*2.00*	*18.00*	Bn, T,			*2.47*	Bl, Bn, T	*2.47*				
777			26.94				2.52		2.52				
			25.00	Bn			*2.47*	Bn	*2.47*				
573			19.62				4.54		**4.54**				
575			20.34				4.50		**4.50**				
586			19.01				4.85		4.85				
606			19.79				4.35		**4.35**				
778			19.52				4.88		4.88				
779			19.39				4.92		4.92				
780			20.03				4.38		**4.38**				
781			20.11				4.37		**4.37**				
			19.00	Bn, T			*4.94*	Bl, Bn, T	*4.94*				
607			19.51				3.20		3.20		5.19		2.06
757			20.44				3.41		3.41		**3.32**		
758			19.67				3.36		3.36		5.29		2.08
			19.00	Bn, T			*3.25*	Bl, Bn, T	*3.25*		*5.00*		
604	**10.53**	6.86	17.39				4.03		**4.03**		5.58		0.64
	12.00	*5.00*	*17.00*	Bn, T			*4.40*	Bl, Bn, T	*4.40*		*5.00*		
679			19.80										
			19.23										
683							12.72		12.72				
							12.00		*12.00*				
782			**19.14**				3.97		3.97				
783			24.22				3.29		3.29				
			22.00				*2.50*		*2.50*				

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Union Fertilizer Company, Los Angeles, Cal.—Continued.		
784*	Bone Meal	J. W. Freeman, Upland	27.70
	Guaranteed		*24.40*
633	Fruiting	N. L. May, Rialto	25.06
759	do	E. E. Cole, Redlands	24.64
760	do	H. H. Gardener Co., Anaheim	30.49
761	do	C. A. Miller, Highlands	26.86
	Guaranteed		*24.18*
662	Special Fruiting	L. C. Waite, Riverside	26.33
762	do	E. E. Cole, Redlands	31.69
	Guaranteed		*29.50*
763	Nursery	J. W. Freeman, Upland	26.77
	Guaranteed		*27.70*
764	Orange and Lemon	J. B. Hanna, Colton	22.68
	Guaranteed		*20.62*
765	Special	J. F. Jackson, Riverside	29.55
	Guaranteed		*29.00*
766	Special	J. F. Jackson, Riverside	27.32
	Guaranteed		*29.20*
767	Special	J. W. Freeman, Upland	26.21
	Guaranteed		*27.53*
768	Special	J. W. Freeman, Upland	26.99
	Guaranteed		*29.40*
769	Special	J. W. Freeman, Upland	30.31
	Guaranteed		*29.59*
786	Special	J. F. Jackson, Riverside	30.02
	Guaranteed		*31.18*
	Western Meat Company, San Francisco, Cal.		
785*	W. M. Co. Tankage	Manufacturers	35.48
	Guaranteed		*33.65*
	Woodbridge Chemical Works, San Bernardino, Cal.		
770	Woodbridge Citrus B	Factory	20.78
771	do	Factory	19.07
	Guaranteed		*21.10*
772	Woodbridge Special Citrus B	Factory	24.62
	Guaranteed		*20.50*
623	Woodbridge Orange and Lemon No. 1	C. N. Ross, Etiwanda	31.06
	Guaranteed		*28.90*
789	Woodbridge Orange and Lemon No. 1	B. K. Brant, Upland	32.60
	Guaranteed		*28.30*
608	Nitrate of Soda	J. S. Kuns, Covina	51.68
	Guaranteed		*51.15*
787	Special	S. E. Gilbert, Colton	25.92
	Guaranteed		*26.20*
	Commercial Industrial Manufacturing Co., Los Angeles.		
609*	Sheep Manure and Gypsum	L. C. Whaley, Redlands	

*784—33 per cent fine.
*785—82 per cent fine.
*609—Not registered. Contains 14.35 per cent gypsum.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
784	------	----	18.48	------	------	------	3.80	----------	3.80	------	------	------	
	------	------	*22.00*	------	------	------	*2.00*	----------	*2.00*	------	------	------	
633	7.93	1.17	9.10	------	0.35	0.83	1.79	----------	2.79	------	3.65	------	1.94
759	7.91	0.71	8.62	------	0.15	0.99	1.90	----------	3.04	------	3.24	------	1.10
760	8.77	2.59	11.36	------	0.38	1.20	2.47	----------	4.05	------	3.51	------	1.48
761	8.63	0.98	9.61	Bn, G, T Super	0.36	0.93	1.70	----------	2.99	------	4.46	------	1.24
	7.00	*2.00*	*9.00*		*0.75*	*0.60*	*1.65*	Bn, G, T	*3.00*	------	*3.50*	------	
662	7.86	0.11	7.97	------	2.23	0.26	1.01	----------	**3.54**	------	4.09	------	5.94
762	9.44	1.43	10.87	Bn, G, T Super	0.38	1.45	2.09	----------	3.92	------	4.71	------	1.56
	8.00	*2.00*	*10.00*		*1.00*	*0.75*	*2.25*	Bn, G, T	*4.00*	------	*4.00*	------	
763	6.23	1.21	7.44	Bn, G, T Super	2.44	0.29	1.97	----------	**4.70**	------	2.08	------	4.64
	6.00	*2.00*	*8.00*		*1.00*	*1.00*	*3.00*	Bn, G, T	*5.00*	------	*1.50*	------	
764	7.97	1.06	9.03	Bn, G, T Super	0.33	0.83	1.36	----------	2.52	------	3.01	------	1.24
	7.00	*2.00*	*9.00*		*0.60*	*0.50*	*1.40*	Bn, G, T	*2.50*	------	*2.00*	------	
765	------	------	8.48	Bn, G, T Super	0.55	1.82	4.00	----------	6.37	------	------	------	
	------	------	*7.00*		------	------	------	Bn, G, T	*6.50*	------	------	------	
766	11.45	1.88	13.33	Bn, G, T	0.72	0.41	1.14	----------	2.27	------	**3.90**	------	
	12.00	*2.00*	*14.00*		------	------	------	Bn, G, T	*2.40*	------	*4.50*	------	
767	8.17	1.28	9.45	------	------	------	4.09	----------	4.09	------	**0.87**	------	0.82
	8.15	*1.30*	*9.45*	Bn, G, T Super	------	------	------	Bn, G, T	*4.25*	------	*1.50*	------	
768	**12.97**	2.13	15.10	Bn, G, T Super	0.46	0.35	0.89	----------	1.70	------	**3.65**	------	
	15.00	*1.00*	*16.00*		------	------	------	Bn, G, T	*1.40*	------	*5.00*	------	
769	13.90	2.42	16.32	------	0.61	0.36	1.05	----------	2.02	------	**4.44**	------	0.58
	13.55	*2.68*	*16.23*	Bn, G, T Super	------	------	------	Bn, G, T	*1.71*	------	*5.00*	------	
786	14.67	2.27	16.94	Bn, G, T Super	0.56	0.25	0.86	----------	1.67	------	**4.52**	------	
	14.25	*2.75*	*17.00*		------	------	------	Bn, G. T	*1.57*	------	*6.00*	------	
785	------	------	8.74	------	------	------	8.38	----------	8.38	------	------	------	
	------	------	*7.00*	------	------	------	*8.25*	----------	*8.25*	------	------	------	
770	5.20	3.25	8.45	------	------	------	2.12	----------	**2.12**	------	4.40	------	
771	8.60	1.84	10.44	------	------	------	0.88	----------	**0.88**	------	3.88	------	
	5.00	*5.00*	*10.00*	Bn, G	------	------	*2.50*	Bl, Bn, G	*2.50*	------	*3.00*	------	
772	6.51	5.27	11.78	------	------	------	2.47	----------	2.47	------	4.40	------	
	5.00	*5.00*	*10.00*	Bn, G	------	------	*2.00*	Bl, Bn, G	*2.00*	------	*4.00*	------	
623	6.07	4.71	10.78	------	------	------	3.90	----------	3.90	------	6.16	------	
	5.00	*5.00*	*10.00*	Bn, G	------	------	*4.00*	Bl, Bn, G	*4.00*	------	*5.00*	------	
789	9.89	1.25	11.14	------	3.56	------	0.62	----------	4.18	------	5.10	------	2.48
	5.00	*5.00*	*10.00*	Bn, G	*2.00*	------	*2.00*	Bl, Bn, G	*4.00*	------	*5.00*	------	
608	------	------	------	------	15.54	------	------	----------	------	------	------	------	0.60
	------	------	------	------	*15.50*	------	------	----------	------	------	------	------	
787	**6.57**	3.36	9.93	------	------	------	3.14	----------	3.14	------	4.21	------	
	8.00	*2.00*	*10.00*	Bn, Super	------	------	*3.00*	Bl, Bn	*3.00*	------	*4.00*	------	
609	------	------	0.73	------	------	------	0.62	----------	0.62	------	0.27	------	

STATION PUBLICATIONS AVAILABLE FOR DISTRIBUTION.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1898. Partial Report of Work of Agricultural Experiment Station for the years 1895-96 and 1896-97.
1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-1903.
1904. Twenty-second Report of the Agricultral Experiment Station for 1903-1904.

BULLETINS.

Reprint. Endurance of Drought in Soils of the Arid Region.
No. 128. Nature, Value and Utilization of Alkali Lands, and Tolerance of Alkali. (Revised and Reprint, 1905.)
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133. Tolerance of Alkali by Various Cultures.
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169. Tolerance of the Sugar Beet for Alkali.
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172. Further Experience in Asparagus Rust Control.
173. Commercial Fertilizers. (December, 1905.)
174. A New Wine-Cooling Machine.
175. Tomato Diseases in California.
176. Sugar Beets in the San Joaquin Valley.
177. A New Method of Making Dry Red Wine.
178. Mosquito Control.

CIRCULARS.

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REPORT OF PROGRESS IN CEREAL INVESTIGATIONS.

By G. W. SHAW.

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CEREAL INVESTIGATIONS.

By G. W. SHAW.

ORGANIZATION.

In the strenuous endeavor to introduce into California new crops, and to hasten the time when the extensive system of wheat farming shall give place to the more intensive culture of fruits and numerous other crops suited to more limited areas, the underlying principles which make for profit in the culture of cereals have been well nigh lost sight of until neither the quality nor the quantity of our wheat is what it might be.

The quality has not kept pace with the more advanced demands of the milling and the baking trades. To such an extent is this true that notwithstanding the heavy production and exportation of wheat in the year ending June 30, 1905, we were under the necessity of importing, to maintain the flour trade, 4,006,680 bushels of foreign-grown wheat.

Could we stop these importations and supply the milling trade entirely from California-grown wheat it would mean a saving to our people of over $1,500,000 annually now passing out of the State.

The particular feature which has dominated wheat culture in California, and on the Pacific Coast generally, has been mass production, rather than maximum product per unit of area, or quality of the product. But with the inevitable ultimate deterioration of soil under such a system, heightened by the encroachment of other crops, and the continued open culture practiced with this crop, there has been a notable falling off in the production *in toto*, as well as in the yield per acre, during recent years.

While wheat farming on an extensive scale is not a thing to be highly encouraged when the natural conditions are such as to make more intensive crops safe, yet it is still, and is destined to be for all time, a very important industry in California; and as one of the staple crops of a general farm, is worthy of not only much encouragement, but also the greatest aid that can be given it by scientific research. Further, on account of climatic and other conditions, there will be, at least for many years to come, sections of the State in which cereal culture will be the principal interest.

With these conditions in mind, and mindful as well of the great improvement that has been brought about in the Middle West in this and related lines, the writer, as representative of the Experiment Station, in the fall of 1904, undertook to unite various interests in the State, viz, the millers, shippers, and growers, as well as such commercial bodies as the Merchants' Exchange, State Board of Trade, and the Sacramento

Valley Development Association, in a concerted movement toward cereal improvement. Through the active and substantial aid of all these parties and organizations, the Experiment Station was enabled to begin active work toward cereal improvement in the fall of that year, the chief points in view being to discover or produce such wheat as (1) will yield the largest profit per acre for the farmer, and will supply the millers with wheat of superior quality; (2) to conduct such similar experiments with oats, barley, and other cereals, as may be desirable; (3) to determine the effectiveness of various methods of culture as affecting the cereal industry; (4) to determine the effect of changes of environment upon the growth of cereals, particularly the composition of the wheat kernel.

As a result of private subscription, funds were made available to partially equip two field stations in the large wheat-growing sections of the State, and a cereal laboratory where milling and baking tests, as well as the necessary chemical work connected with the investigations, may be conducted.

Realizing the importance of this movement to the State generally the Legislature at its session of 1905 passed the following Act, which was promptly signed by the Governor:

[Senate Bill No. 10.]

AN ACT TO PROVIDE FOR THE IMPROVEMENT OF THE CEREAL CROPS OF CALIFORNIA, AND APPROPRIATING MONEY THEREFOR.

The people of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. The Governor of the State of California is hereby directed, and it is hereby made his duty to cause to be made, under the supervision and direction of the Director of the Agricultural Experiment Station of the University of California, such investigation and experiments as he may deem best for the purpose of discovering and making known such improved methods of cereal culture in the State of California as will increase the yield of cereals in said State, and increase the percentage of gluten in said cereals, or otherwise improve the quality thereof. The said Governor shall have the exclusive charge and control of all moneys appropriated hereby, to be used in employing such expert and scientific assistants as he may deem necessary, and for the paying of the expenses of carrying on the experiments and investigations herein provided for. He shall from time to time publish the results of such experimental and investigational work as may have been done, for general distribution.

SEC. 2. The sum of ten thousand dollars, or so much thereof as may be necessary, is hereby appropriated out of any moneys in the State Treasury not otherwise appropriated, to be paid to the Governor to be used for the purposes of this Act, one half thereof to be expended during the fifty-seventh fiscal year, and one half thereof to be expended during the fifty-eighth fiscal year, and the Controller is hereby directed to draw his warrant on the General Fund from time to time for such proportion of said sum of ten thousand dollars, and in favor of such persons as the Governor shall direct; and the State Treasurer is hereby empowered and directed to pay the same.

SEC. 3. This Act is exempted from the provisions of section six hundred and seventy-two of the Political Code.

SEC. 4. This Act shall take effect and be in force from and after the date of its passage.

Assured of this ready support the Station was able to plan its work upon a more comprehensive scale than at first contemplated, and at

once entered into a coöperative agreement with the United States Department of Agriculture, the provisions of which are set forth below:

I. That the California Agricultural Experiment Station, subject to the approval of the governing board, shall provide the necessary land and buildings, teams, machinery for planting, cultivating, harvesting, and threshing, and all ordinary labor, apparatus, and other supplies, and shall make available for use seeds of varieties already under experiment and results obtained from experiments conducted at the main Station.

II. The Bureau of Plant Industry shall, subject to the approval of the Secretary of Agriculture, furnish seed of all hybrids and standard varieties now in its possession that are likely to be at all adapted for these experiments, and seed of any other new varieties of similar adaptation, and shall provide for one special agent to be in direct charge of the field plat experiments, variety tests, breeding work, etc., the personnel of the special agent to be determined by mutual agreement.

III. The investigations carried on under this coöperative memorandum shall be planned and conducted conjointly by the duly authorized representatives of the California Agricultural Experiment Station and the Bureau of Plant Industry, and shall be subject to the approval of the proper authorities in each case.

IV. The seeds of all new varieties of special value developed during these investigations shall be distributed in the localities in which they prove to be of value, but particularly in the State of California, the distribution to be made in accordance with such plan as may be jointly agreed to by the Station and the Bureau. In the larger plat-tests of introduced varieties one half the amount of grain produced from each variety in excess of the seed required for a second sowing, in all cases where the seed came from the Bureau of Plant Industry, shall be subject to the disposal of the Bureau, the other half to remain the property of the California Agricultural Experiment Station; *provided*, that when sown under field conditions in areas of two acres or more, and the Bureau of Plant Industry bearing no expense in the cultivation of the crop, all seed harvested shall belong to the California Agricultural Experiment Station after deducting the amount of seed originally furnished by the Bureau; *provided further*, that in case the seed is not desired for distribution the whole will revert to the California Agricultural Experiment Station, and said Station agrees to apply the proceeds from any grain sold from these coöperative plats to the continuation of such experimental work.

V. At the close of each season's experiments a report in detail of the results of the season's work shall be submitted by the special agent in direct charge of the field work, one copy each to be furnished to the Bureau of Plant Industry and to the California Agricultural Experiment Station. So far as possible threshed samples of the grain of all varieties under experiment and unthreshed samples, when particularly desirable, shall accompany the report in each case, such report and samples to be delivered not later than October first of that year.

VI. Both parties to the agreement shall be free to use in their official correspondence and in publications the results obtained in these investigations, giving proper credit to the fact that such results were obtained through this coöperative work, and provided that it shall be understood, in case of publications, that the California Agricultural Experiment Station shall give preference to results that are of direct interest to the State of California, and the United States Department of Agriculture shall give preference to results that are of interest in connection with similar lines of work in other parts of the country.

Under this agreement Mr. L. A. Fitz was detailed by the Department of Agriculture as the special agent on its behalf, and Prof. A. V. Stubenrauch was placed in charge of the cultural work on behalf of the California Station, the writer remaining in charge of the chemical and technical phases.

Previous to the appropriation made by the Legislature, the work had been started under private subscription, as indicated earlier in this circular, and it so continued until June 30, 1905, at which time the

writer was placed in charge of both field and technical phases on the part of the Station. On account of the lateness of the season when the work was begun in 1904, and the uncertainty as to the actual support which could be depended upon, no other lines of field work were laid out than simple variety tests as to adaptability (preliminary to systematic work in selection), hybridizing, and adaptation, such preliminary work in the field being essential in order to make certain of securing desirable varieties and vigorous stocks as a basis for improvement.

Two sites of twenty acres each were selected on which to conduct the field trials—one at Modesto, Stanislaus County, as representative of the general cereal conditions in the San Joaquin Valley, and the other at Yuba City, Sutter County, representing those of the Sacramento Valley. Leases were taken on each of these tracts for a period of years at the option of the Station, and work was immediately begun, even though it was late in the season.

After the first season, on account of the extreme weediness of the original tract selected at Yuba City, it was deemed best to change the location of the station to another site in the immediate neighborhood and having the same general soil conditions.

GENERAL NATURE OF THE SOILS OF THE STATIONS.

The soil at the Modesto station is of a deep, loose, silty nature, very similar to those popularly known as the San Joaquin Valley "white ash" lands. There is a very small amount of clay in these lands, the fine matter consisting mostly of silt. The land has been under cereal cultivation for thirty years or over, and still produces fair crops when summer-fallowed. The humus and the phosphoric acid content is quite low, and the moisture-holding power is low, especially under the strong action of the drying north winds, which frequently blow for several days at a time in that locality. It is regarded as one of the best wheat-growing sections of the San Joaquin Valley, and is typical of a large area of land.

The soil at Yuba City in its general physical character is almost the opposite of that at Modesto. It is gray in color, and works very much like a stiff clay, but in reality the fine material is an extremely fine silt. Under the drying action of the sun and wind it is inclined to bake quite hard, and is quite difficult to work unless taken at exactly the right time. It can not safely be put in so fine a condition as can the Modesto land. The land has been long under cultivation. It is fairly well supplied with humus, resulting from the rank growth of vegetation after the crop is taken off, the bur-clover growth being especially heavy. The tract is quite even in character, but the weediness of the land makes plat comparison somewhat unsatisfactory. Really satisfactory plat work can not be done until a tract can be cleaned of its weeds. This is

especially true when small plats are used, as in the case of centgener plats, and for this reason most of such work is being done at Modesto where the weeds are not so troublesome.

On each of the stations a portable house has been erected to serve as a seed-house and for the protection of the implements. Each station has also been supplied with such necessary tools as could not be readily hired in the open market, including, in addition to the hand tools for

FIG. 1. Seed-house and thresher at the California Cereal Stations.

seeding and cultivating the row plantings, a self-binding harvester, a special "Baby Vibrator" threshing machine, a gasoline engine for power, fanning mill and, for the Modesto station, a Campbell sub-surface packer for dry land culture.

WORK OF 1904-5.

On account of the lateness of the season, it was impracticable to undertake other field work for the first season than the collection and field trial of varieties. Further, since the plan contemplates the application of the principles of both straight selection and of crossing followed by selection, it was necessary to thoroughly try out the numerous varieties to secure the really strong stocks upon which to begin this work of improvement. Such preliminary trials are as essential to plant breeding as the laying of the foundation of a house is to its subsequent stability. The strongest individual plants of the most promising varieties must be found to act as the parents for future breeding. Otherwise all might be lost through having selected poor varieties, weak plants, or both, as the basis for selection and breeding. A large part of the field work at both stations has been devoted for the past two seasons to this preliminary variety testing, the selection of pure strains and of strong

individual plants. On account of the delay at first, and finally the continued rains in the late fall, it became impossible to prepare the land and sow the grain sufficiently early to obtain any satisfactory results from the winter varieties, as was demonstrated by the fact that many of that class of wheats made no upright growth at all, while the spring varieties and durum wheats planted at the same time produced good heads.

In 1904–5 there were planted at the Yuba City station 275 standard varieties of winter wheat, 65 standard varieties of durum wheats, 66 hybrid wheats, 65 standard varieties of barley, 12 standard varieties of oats, 2 varieties of einkorn, 2 varieties of emmer, and 21 varieties of corn. With the exception of the corn varieties, the plantings at Modesto were almost an exact duplication of those at Yuba City.

Early in the season it became apparent that the tract at Yuba City was so very foul with weeds, especially wild radish and mustard, that it would be impossible to obtain any reliable results from the yield tests. All winter varieties make a low, spreading growth for the first few months, consequently these late-sown grains were soon badly overgrown with weeds. *This foul condition of the land will be one of the chief difficulties to be overcome in many localities before winter varieties of grain can be successfully grown in California.* Varieties which were of the nature of spring grains made a more rapid upright growth, which enabled them to keep the weeds somewhat in check.

This was a strong point in favor of the durum wheats. Some of the same varieties of durum wheats were planted both in January and in March, and while those sown in March did quite well the heads were not so large nor so well filled as were those sown the first week of January.

Spraying to Destroy Weeds.—Some experiments were made to test the effect of spraying the plats at Yuba City with a solution of copper sulfate to kill the wild radish. The results were not very satisfactory as a whole. In many of the plats the weeds were so large that even one hundred gallons per acre of the solution would not cover the weeds sufficiently to kill them. In cases where very small plants were sprayed the weeds were killed, but the land was so infested with seed that every shower caused more plants to grow. This condition would require successive sprayings, which makes the cost too excessive. A solution of one pound of copper sulfate to two gallons of water and applied at the rate of about one hundred gallons per acre proved effective in killing young plants of the mustard and radish, besides various other weeds, without resulting in permanent injury to any of the cereals. In some cases the upper portion of the blades turned brown at first, but growth was not retarded materially, and in a week or ten days the plants had resumed their usual green color.

The winter wheats at Yuba City did better than at Modesto, but this was doubtless due to the fact that they were started earlier. Nevertheless, the extreme weediness of the land was such a serious handicap as to make yield tests absolutely unreliable. The winter wheats sown at Yuba City the first week of January ripened the last of June, thus maturing in a shorter growing period than they usually require in the winter wheat district of the East. However, they would undoubtedly make better growth and give better yields if sown in October and November.

Among the earliest maturing varieties were No. 1181, Japanese No. 3; No. 2126, Kurd; No. 2198, Piola Karte; No. 2200, Karum; No. 2204, Humera; No. 2205, Kharta; No. 2399, Shet Gahu.

A number of the durum varieties grown in small hand plats at Yuba City were very promising. Some of them produced a very good quality of grain, which shows but little tendency to become starchy. Others contained a larger per cent of spotted or starchy grains.

Among the best varieties of durum wheats were: No. 1494, Arnautka; No. 1567, Novorossick; No. 1572, a durum from Pierpont, S. D.; No. 1589, Biancolillo; No. 1593, Marouani; No. 1595, Kahla; No. 1597, Medeah; No. 1736, Iumillo; No. 2090, Negro; No. 2127, Hurma.

Varieties of durums showing a large number of spotted grains were:

1350. Pererodka.
2198. Piola Karte.
2206. Khandwa.
2234. Kubanka.
2247. Velvet Don.
2587. From Sardinia.
2592. From Buenos Ayres.
2200. Karum.
2221. Kubanka.
2246. Kubanka.
2575. From Bulgaria.
2591. From Buenos Ayres.
2598. From Entre Rios, Argentine Republic.

Of the wheats commonly called bread wheats the following were very promising: No. 1181, Japanese No. 4; No. 1596, Fretes; No. 1698, Allora; No. 2227, Chul; No. 1442, Kharkov; No. 1699, Canning Downs; and No. 1436, Crimean.

A wide difference was found between samples of grain from the same varieties grown under different conditions. The grain from some of the large plats which were so badly infested with weeds, and not cut quite as soon as it was ripe, was much lighter in color and apparently softer than that of the same variety grown in small row plats where the weeds were kept hoed out and the grain cut in proper time. *From all the evidence obtained in this first year's work, we believe the grain will be of much better quality if cut as soon after ripening as possible.*

At Modesto the only winter varieties which produced any grain were No. 2227, Chul wheat; No. 1698, Allora wheat; No. 276, Belgian Winter oats; No. 338, Culberson Winter oats; and No. 40, Abruzzes rye. All other varieties made no upright growth and consequently produced no heads. This indicates that in most cases it is unwise to sow winter wheats in the Modesto section later than the middle of December,

although Chul was sown December 28th and Allora January 6th, showing them to be of rapid growth and to be early maturing varieties.

While on account of the extreme conditions which obtained throughout the season, viz: the late seeding, and the extreme rust condition resulting from continued warm rain in the spring, the result of yields can not be considered at all reliable, and in all cases was much below the normal, still much of value was obtained as to the characteristics of a large number of grains under such untoward conditions, especially with regard to time of ripening and rust resistance, and character of growth, and the susceptibility to change under California conditions, all of which are factors of importance, and have a direct bearing upon the selection of desirable varieties to serve as foundations for subsequent improvement.

SOME LESSONS FROM THE RUST EPIDEMIC OF 1904-5.

The season was characterized by one of the severest attacks of grain rust which the State has ever seen. In general, it may be said that the grain rusts do not do a large amount of damage in the State. About once in ten years the State as a whole suffers more or less from both leaf and stem rust, but throughout the coast section much damage is done to the grain crops nearly every year. The atmosphere of the interior valleys is usually too dry for the rust to spread. In 1904 however, rains occurred until quite late in the spring, and after ea rain occurred a few days of moist warm weather, thus making ideal conditions for the development of rust. Not only wheat, but also barley and oats, were seriously affected in a great many cases.

One of the most valuable things learned from the field trials of this season was the effect of the rust upon the large number of varieties on the stations.

NATURE OF RUST.

Without going into a scientific discussion of grain rust it may be summarily said that the rust is a plant as distinct in kind as the grain upon which it grows, and propagates itself by spores which correspond to the seeds of higher plants. These spores are carried by the wind and grow only when they alight upon a living plant. The condition favorable for rapid growth of the rust plant is humidity of atmosphere and warm days, conditions which are also conducive to rapid growth of the grain, hence it often happens that the heaviest grain is most severely attacked.

There are two distinct kinds of rust that affect both wheat and oats. One of these, the "leaf rust," so called because its principal point of attack is the leaves, comparatively speaking does but little damage. The black stem rust, however, in seasons of unusual severity is the cause of enormous loss. It occurs a little later than the leaf rust.

While these rusts are given the distinguishing names above used, yet each has a black stage and a red stage, and are thus difficult to distinguish.

Since it is the later appearing stem-rust that does the greater damage, those varieties of grain that mature early are the least affected by the disease, because if planted early they mature before this rust appears in considerable quantity. The period at which the greatest damage is done is while the head is filling, between the date of flowering and the date of ripening.

The comparative rust resistance, stated in per cents, between a number of the common wheats and the durums grown under the same conditions at Yuba City in 1904–5, is shown in the subjoined table:

TABLE I. Showing Relative Rust Resistance of Certain Wheats—Yuba City, 1904–5.

COMMON WHEATS.

No.	Name.	Rust Resistance, per cent.
647.	Onigara	75
682.	Early Japanese	80
1181.	Japanese, No. 4	85
1184.	Japanese, No. 1	80
1356.	Theiss	50
1433.	Crimean	70
1436.	Crimean	70
1437.	Crimean	55
1438.	Ghirka Winter	70
1439.	Ultra	65
1442.	Kharkov	50
1539.	Targorva	70
1558.	Turkey	75
1561.	Theiss	40
1563.	Weissenberg	80
1564.	Pesterboden	80
1587.		65
1596.	Fretes	50
1697.	Early Baart	20
1698.	Allora	85
1699.	Canning Downs	85
1732.	Fish Head	95
1733.	Dawson's Golden Chaff	40
1746.	King's Early	10
1923.	Fultz	40
2126.	Kurd	40
2200.	Buetha	50
2227.	Chul	40
2204.	Humera	--
2205.	Khata	--
2219.	Padi	--
2397.	Red Winter	65
2824.	Elephant Hybrid	50
2825.	Elephant Hybrid	50
2826.	Bobs	35
2828.		20
2830.		12
2496.	Kissilbugda	20
2495.	Red Winter	40
293/04	California Gem	20
	Sonora	20
	White Australian	20
	Washington Bluestem	30

DURUM WHEATS.

No.	Name.	Rust Resistance, per cent.
1494.	Arnautka	95
1567.	Novorossick	95
1572.		95
1589.	Biancolillo	95
1593.	Marouani	98
1597.	Medeah	99
1595	Kahla	95
1736.	Iumillo	95
2006.	Nicaragua	97
2074.		77
2075.	Abd-el-Kaden	93
2076.	Medeah	95
2077.	Azizi	95
2078.	Sboo-el-Roumia	95
2087.	Bachir	97
2088.	Kahla	98
2089.	Richi	95
2090.	Negro	90
2091.	Albacete	90
2093.	Berberisco	90
2099.	Mahmoudi	99
2124.	Hurma	80
2127.	Hurma	75
2198.	Piola Karte	60
2221.	Kubanka	90
2228.	Saragolla	95
2234.	Kubanka	90
2235.	Marouani	93
2246.	Kubanka	97
2247	Velvet Don	98
2399.	Shet Gahu	65
2527.	Algerian Durum	90
2537.	Algerian Durum	90
2546.		90
2547.		90
2598.		90
2607.		90
2609.		90
2640.		90
2641.		90
2649.		85
2651.		85
2689.		90
2692.	Realforte	90
2756.		90
2827.	Coolabak	95
2/05.	Chilean Wheat	95
3/05.	Chilean Wheat	95

FIG. 2. Kubanka variety of durum wheat grown at Modesto, 1905-6.

THE RUST RESISTANCE OF VARIETIES.

There were quite a number of the varieties under observation that were almost wholly rust resistant in this season, and on this ground seem desirable varieties for further trial in the coast section of the State especially. While one season's observation can not show much that is conclusive, yet the severity of the rust condition renders the work of a single season of this character of much value. To such an extent is this true that although the conditions were so unfavorable as to vitiate nearly all of the yield tests, yet the observations upon the relative rust resistance of the varieties may be of greater value than the entire cost of the experiment. At least one very important series of observations was secured, then, during the season's operation, not to mention numerous other lesser ones that will have important bearings upon the future selection of grains. To know that under similar conditions of soil preparation and culture certain wheats are affected only to an extent of 5 per cent, while others are affected to an extent of 90 per cent, and these latter our common varieties, is an exceedingly important fact.

These results make it very evident, first, that the durum wheats are much more rust resistant than any of the common varieties grown; second, with the exception of a comparatively few varieties there does not seem to be much difference in this respect between the varieties of durums themselves. Among the common wheats there was a wide difference, the range being from 10 to 85 per cent resistance. In all cases the commonly grown California varieties proved to be much more subject to rust than, for instance, No. 1181, Japanese; Nos. 1433 and 1436, Cri-

mean; No. 1558, Turkey; No. 1564, Pesterboden; No. 1698, Allora; and No. 1699, Canning Downs. It will be interesting to know what these varieties may do in the coast regions in the State where rust conditions are an annual factor. They will be thoroughly tried out in that region in comparison with the common California varieties, and should they maintain the record made in 1904–5, their introduction into that region will prove extremely valuable. With the results of only a single year of serious rust conditions before us, however, we do not feel warranted in recommending extensive plantings, although any of them are worthy of further trial and selection under rust conditions. Mention should also be made of two other varieties which, under the condition of extemely late sowing, did well, viz., No. 1596, Fretes, and No. 2227, Chul. The former resisted the rust better than the latter, and some sown as late as March 6th made good heads with very good kernels, although the heads were not as well filled nor as large as were those of an earlier sowing. Both of these varieties make a quick upright growth, and if sown at the usual time of seeding may prove excellent wheats.

BARLEYS AND OATS AND CORN.

A number of barleys and several varieties of oats were grown in both large and small plats to secure indications as to adaptability, some of which gave promising results. Among the six-rowed barleys, Beldi (No. 190) and Mariout (No. 261) were the earliest. Of the two-rowed, Black Smyrna (No. 191) and White Smyrna (No. 195) were much the earliest on the list.

Sixty-day oats (No. 165) was the earliest oat variety, while No. 291 (White oats from England) gave the best yield. The winter varieties of oats and barley were sown too late to give any fair idea as to results.

Of the *corn* varieties planted at Yuba City, Early Tuscarora, Gehu, and Red Dent are very early, and had nearly matured by the latter part of July. The extremely hot winds during the first week of July injured all varieties just tasseling at that time. The tassel and upper blades were completely dried and turned white. The growth of all varieties in early spring was very slow. One or two varieties planted from two to three weeks later were standing the drought very well and were of a deep green color with scarcely any of the lower blades fired the last of July.

None of the corn plantings produced good ears, on account of the scorching in July. The corn experiments may be regarded as a total failure. *Except under the most favorable climatic conditions, corn culture on the uplands without irrigation is regarded as very doubtful.*

THE OPERATIONS OF 1905-6.

The writer took charge of the cereal work at the beginning of the fiscal year 1905–6. On the part of the United States Department of Agriculture Mr. H. F. Blanchard was assigned to duty in California in place of Mr. Fitz.

The writer at once proceeded to lay out detailed plans for permanent work. The nature of this work is such that no permanent results can be secured from one or two seasons' operations. *The element of time is an all-essential one for the solution of such problems as are before us.* This would be true even though the problem was merely the development of wheats giving higher yields than those now being grown in the State, but with the introduction of the problem of increasing the gluten content, the element of time is of even greater importance. With this in view the experiments were so planned that while the ultimate end can not be expected for several years, yet data of much importance as bearing upon the entire question of cereal culture should be obtained each year, and thus material progress made annually.

The general plan adopted as the permanent policy of the investigations on both stations is presented below. The experiments will have to deal primarily with wheat, but barley and oats will also be included, and the general method of procedure will be the same in all cases.

The plantings on the stations are divided into three classes:

CLASS I. Nursery plantings.
- (*a*) Of varieties under preliminary trial.
- (*b*) Of varieties undergoing straight selection.
- (*c*) Of hybrids and selection following hybridization.
- (*d*) Small increase-plats.

CLASS II. Field plantings.

CLASS III. Special experiment plantings.

The nursery plantings under Class I refer to all plantings of small size, varying from a single grain of wheat in some cases to increase-plats less than one-twentieth acre in size. The nursery plantings are divided into four sub-classes, as indicated in the tabular scheme presented above.

Under Class I (*a*) are introduced all new varieties secured from various sources, and only the ones showing special adaptability to California conditions are selected for advancement to Class II in field trials, and to I (*a*) for improvement by selection—only the best of the class being selected for the latter work. The varieties undergoing straight selection, I (*b*), are those which are in the field plantings and others that may have shown such very favorable characteristics as to warrant marking them "excellent" after satisfactory preliminary trial in the nursery. Plantings under this subdivision, I (*b*), were made for the first time in the fall of 1906. These plantings are made after the centgener system, which is explained later on. On account of the difficulty with

FIG. 3. California Cereal Station at Modesto.

weeds at the Yuba City station, and the greater ease with which the soil can be handled at the Modesto station, the centgener plantings are mostly made upon the latter. The plantings under Class I (*c*) are devoted to fixing the characters of the hybrids developed on the stations and finally improving such as may prove desirable by selection after the centgener plan. Sub-class (*d*) embraces such varieties as are being increased for field trial after having been proven in I (*a*).

The field plantings, Class II, vary in size from one-twentieth of an acre to one acre in size, and the varieties grown in these plats are those which previous observations have shown to be worthy of more extensive trial than a limited number of rows employed in the nursery plantings.

The plantings under Class III are those devoted to special experiments, as detailed later in the publication.

The work on the two stations for the season 1905–6 is presented separately below, but in all cases must be taken merely as a report of progress rather than as completed experiments, the accumulated results of several seasons' work being necessary before definite conclusions can be drawn even from the special experiments.

WORK AT THE YUBA CITY CEREAL STATION, 1905-6.

As indicated earlier in this bulletin the location of this station was changed at the beginning of this fiscal year, the location selected being only a short distance from that of 1904–5, and the soil conditions remaining essentially the same. The previous season the tract had produced a crop of barley, and the season's rains coming very late there was much delay, so that the winter varieties were seeded later than they should have been to give the best results; and further, the volunteer barley was troublesome throughout the entire season. The entire tract was seeded, the plantings varying in size from a few rows to one acre.

Preparation of the Land.—Preparation of the soil was begun early in December, 1905, when it was given a surface disking to cover the weed seed and put the surface in such shape that it would readily take moisture. The disking was done as early as there was sufficient rain to moisten the first two inches of surface soil. There was not sufficient moisture to allow plowing until the first of January, and even then in parts of the field the land turned over in a very lumpy condition. Rains, however, followed soon after the seeding and disintegrated the clods. The land was plowed with a gang plow five to seven inches deep, then disked, harrowed, and put into as good condition as the limited moisture would allow.

Method of Planting.—As soon as the land was plowed and harrowed the seeding of winter wheats was commenced. At the time of seeding the winter wheats the land was very rough, but on account of the lateness of the season it was deemed inadvisable to wait longer for rain to allow a first-class seed-bed to be prepared; still, it ultimately proved better than at Modesto, as the ground was not as loose as at the latter place, which resulted in a quicker and stronger germination of most varieties of the grain. There were numerous heavy rains at this time, and it was with considerable difficulty that the seeding was accomplished, as the soil would no sooner dry out enough to work than there would be more rain. However, seeding of both large and small plots was completed by February 1, 1906.

All plat plantings were done with a Monitor double-disc drill, while the small plantings were made with a Planet Jr. hand drill. On all plats seeded with the Monitor drill 72 pounds of wheat seed was used in drill rows six inches apart. From the general appearance of the plats after germination, and throughout the season, it is probable that better results would have been obtained by the use of more seed. This is particularly true when seeding is not done until January, for the

plants do not seem to stool as well at this time as when germination takes place earlier. Further, a thicker seeding will keep down a larger number of weeds.

Weeds.—The weed question in the Sacramento Valley generally is "a condition and not a theory," and is, perhaps, the greatest difficulty which will have to be overcome in attempts to grow the spreading varieties of winter wheats. The weeds locally known as wild oats, Napa thistle, bur-clover, dog fennel, and morning-glory are rampant throughout the entire region, but at Modesto the California poppy is the only really troublesome weed at the present time.

Although it is the common practice of farmers to bare summer-fallow the land, we are not doing so on this station, which makes it more difficult to deal with the weed problem than would be the case under a thorough system of summer-fallow; however, by cutting the grain in the hard dough stage with the binder, many weeds are destroyed which would be reseeded by the use of the combined harvester, so commonly used in California.

SUMMARY OF PLANTINGS AT YUBA CITY, 1905–6.

Standard varieties of common and durum wheats	325
U. S. Department of Agriculture hybrids	72
Kansas hybrids	66
Barleys	60
Oats	21
Spelt	1
Rye	3
Emmer	2
Einkorn	1
Corn	15
Total	566

PLANTINGS AT YUBA CITY UNDER CLASS I, 1905–6.

It is under the sub-group I (*a*) that all the new varieties of wheats are introduced for preliminary trial. Under this division in 1905–6, 463 varieties of wheat were grown upon the Yuba station, these wheats coming from all over the world. No attempt will be made here to present the characteristics of all these wheats, but only to place upon record such as to the present time have shown themselves to be worthy of further trial. For the most part these wheats have been under observation for two seasons, and this season for one cause or another we have been able to eliminate a number from the list of those grown. It was found that many of these standard varieties were mixed with other varieties, and to keep our own seed from becoming badly mixed, it has in most cases been necessary to hand pick the heads, and in so doing occasion has been taken to select only the best heads for the next year's seeding. Thus the varieties have had the benefit of two years' preliminary selection, should it be desirable to

introduce any of them into the centgener plantings for rigid selection during the coming season. Among these row plantings there are quite a number which offer much promise as being very well adapted to the conditions which here obtain.

CHARACTERISTICS OF WHEATS DESIRABLE FOR CALIFORNIA.

Considered only in relation to field conditions there are certain special characteristics which are extremely desirable for wheats which are to be introduced into this State. The following are considered the most prominent of these: manner of growth, tenacity, days to mature, character of head (especially with respect to awns), rust resistance, and heavy yielding plants.

The manner of autumn growth (that is, whether the growth is upright or spreading) is of unusual importance under the present condition of the grain fields as to weeds. Until the farms are in a much cleaner condition than at the present time no wheat is likely to meet with favor unless it will make a reasonably good fight for life among weeds. This factor is not so important in the case of wheats used on summer-fallow land, but in many instances even in this case it is of some importance, because the continued use of the combined harvester, coupled with generally careless methods, has so seriously scattered the weeds in the grain fields as to make even the summer-fallow land exceedingly foul. In such fields the plants that have a low-spreading growth in the fall and winter have but little chance against the weeds. It is the strong upright growth made by the varieties commonly grown in the State that has been one of the main factors which has enabled them to hold their own in the State despite their low milling qualities. This rapid upright growth enables them to successfully keep ahead of the weeds and finally win in the race. With the farms becoming smaller and being given greater care this factor will not be as important. Generally speaking, however, these same spreading varieties require early planting, and for this reason under the conditions of precipitation which hold in large grain-growing sections of the State it is difficult to get them planted, except on summer-fallow land, sufficiently early to have them under favorable conditions for good yield. They must be growing by December 1st to be under even fair conditions, and it is seldom, indeed, except on summer-fallow land, that it would be possible to seed by that date. This will be one of the greatest obstacles in the introduction of these wheats into this State. Our present idea is that they are not well suited to the climatic conditions which obtain in this State generally, unless it be in those parts of the State where limited areas of wheat are grown by irrigation, where a late summer or early fall irrigation can be given the land, thus

TABLE II. STANDARD ROW PLANTINGS, GIVING THE MOST FAVORABLE RESULTS AT YUBA CITY—SEASON 1905-6.

C. I. No.	Name.	Common or Durum.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless.	Tenacity.	Stools.	Average Grains Per Head.	Calculated Number of Grains Per Plant.
293/04	California Gem or Spring	c	E	150	99.5	a	100	3	72	216
647	Onigara	c	Sp	152	100	b	100	3	44	132
682	Early Japanese	c	Sp	152	100	b	98	4	42	168
1184-1	Japanese No. 1	c	Sp	152	100	b	100	5	38	190
1184-2	Japanese No. 1	c	Sp	151	100	b	100	4	40	160
1356-1	Theiss (Hungary)	c	Sp	151	100	a	100	4	44	176
1356-2	Theiss (Hungary)	c	Sp	151	100	a	100	4	38	152
1437	Crimean	c	Sp	151	100	b	100	3	38	114
1438	Ghirka Winter	c	Sp	151	100	b	100	4	38	152
1442	Kharkov	c	Sp	151	100	b	100	4	38	152
1494	Arnautka	d	E	149	100	b	100	3	56	168
1532	Red Wheat	c	Sp	149	100	b	100	3	46	138
1539	Targorva	c	Sp	151	100	b	100	4	30	120
1543	Beloglina	c	Sp	152	100	b	100	3	37	111
1544	Beloglina	c	Sp	152	100	b	100	4	34	136
1557	Carman	c	Sp	152	100	a	100	3	50	150
1558	Turkey	c	Sp	152	100	b	100	4	38	152
1559	Crimean (Miller's improved)	c	Sp	152	100	b	100	4	36	144
1560	Banat	c	Sp	151	100	b	100	3	34	102
1563	Weissenberg	c	Sp	151	100	b	100	4	34	136
1564	Pesterboden	c	Sp	151	100	b	100	5	38	190
1571	Turkey	c	Sp	151	100	b	100	4	34	136
1583	Kharkov	c	Sp	151	100	b	100	3	38	114
1587		c	Sp	149	100	a	99	3	40	120
1596	Fretes	c	E	141	100	b	100	2-4	31	93
1656		c	Sp	151	100	b	100	3	28	84
1658		c	Sp	151	100	b	100	2	30	60
1676		c	Sp	152	100	b	100	4	40	160
1679		c	Sp	151	100	b	100	4	30	120
1691	Winter	c	Sp	151	100	b	100	3	28	84
1732	Fish Head	c	E	162	100	b	100	1-3	52	104
1739	Budapest	c	Sp	153	100	b	98	4	32	128
1746	King's Early	c	E	161	100	b	100	2	48	96
1757	Japanese Velvet Chaff	c	Sp	153	100	b	100	3-4	30	105
1783	Jejar	c	Sp	153	100	b	100	3-4	34	107
2092		c	E	----	----	b	----	----	----	----

2093	Berberisco	d	E	144	100	b	100	1-2	56	84
2099	Mahmoudi	d	E	144	100	b	100	2-3	47	117
2126-2	Kurd	d	E	127	100	b	100	2-3	42	63
2227	Chul	c	E	141	100	b	----	1-2	30	45
2235	Marouani	d	E	145	100	b	100	1-3	50	100
2246	Kubanka	d	E	145	100	b	100	1-2	62	93
2397	Red Winter	c	E	138	100	b	100	1-3	32	64
2527	Algerian durum	d	E	136	100	b	100	1-3	50	100
2585	Realforte	d	E	140	100	b	100	1-2	69	103
2824	Elephant Hybrid	c	E	130	100	b	100	3-6	53	238
2825		c	E	140	100	a	100	2-4	44	132
2826	Bobs	c	E	140	100	a	97	2-4	45	135
2830		c	E	146	100	a	100	1-3	54	108
2691		d	E	144	100	b	100	2-3	44	110
2702		c	E	145	100	a	98	2-4	40	120
2708		c	E	146	100	b	100	2-3	46	115
2720		c	E	145	100	b	98	2-3	40	100
2723		c	E	145	100	b	100	2-3	38	95
2773		c	E	146	100	b	100	2-3	36	100
2776		c	E	147	100	a	100	1-2	40	60
2777		c	E	147	100	b	95	2-3	47	117
2797		d	E	140	100	b	100	1-2	46	69
2805		c	E	146	100	a	100	3-4	42	147
2808		c	E	146	100	b	100	2-3	44	110
----	Marshall's No. 3	c	E	144	100	a	100	3-4	54	189
----	Purple Straw	c	E	143	100	a	100	2-3	38	95
----	Steinwedel	c	E	143	100	a	100	1-2	58	87
----	Smart's Early	c	E	143	100	a	100	1-2	38	57
----	White Australian	c	E	143 & 152	100	a	100	1-2, 2-4	48	120
----	Philippine	d	E	143	100	b	100	2-3	54	135
V.A.C. 205	Japhet	c	E	146	99.5	a	100	3-5	50	200
---	Currell	c	Sp	153	99	a	100	3	38	114
----	Zimmerman	c	Sp	154	99	a	100	3	46	138

c—common; d—durum; E—erect; Sp.—spreading; b—bearded; a—awnless.

enabling the land to be put into condition earlier than otherwise would be possible.

Earliness, as measured by days to mature, is also an important point for consideration in the selection of grains for use in California. The wheats should be such as can be planted as late as possible and will have a rapid growth and mature early, before the exceedingly hot weather comes on in the summer. Further, earliness is a great factor in enabling the wheats, and grains in general, to withstand rust attacks, which are very severe in certain seasons. This is extremely important for wheats grown in the coast counties, for in that region rust is an omnipresent difficulty, owing to the more moist atmosphere. Further, the early wheats are not as apt to be injured by drought as the later maturing varieties.

Bearing upon this last matter the character of the head as to awns is of greater importance than in most places, because it is a custom here, and one which the fickleness of the climate renders almost necessary, for farmers to be governed largely by the character of the season as to whether the crop is allowed to mature its grain or whether it is cut for hay. If the season seems to be unpropitious for the maturing of a fair crop of grain it will be cut before maturity for hay. Thus, an awnless variety is much preferable.

The tenacity with which the chaff holds the grain is also an especially important factor in California, where the combined harvester is so extensively used. Grain frequently stands in the field for a month to six weeks after it is mature, and under the heavy winds which prevail in the San Joaquin Valley, and certain parts of the Sacramento Valley, unless the chaff is very tenacious of the berry there is serious loss. With the use of the self-binder instead of the combined harvester this loses something of its significance, but it will always be a factor of importance. The wheats which have survived in the struggle for existence here have been of this character, and it is one of the principal points in which the Little Club variety appeals to the farmer, and outweighs the undesirable points of this wheat.

The importance of high-yielding plants is too evident to need any discussion. No other characteristic of a plant is so important, and most of those mentioned above have a bearing upon this quality.

It is largely along these lines that the list of grains presented in Table II has been selected as offering the most promise for being useful in further developing the work along the lines proposed. No attempt has been made as yet to select these closely, but rather to exclude those which seemed to offer no superiority to these. Many of the bearded and the spreading varieties are retained because we have not reached a point where it was thought desirable to exclude all these varieties; and, further, some of the best ones may finally enter into the development of new varieties and the beards gotten rid of.

Under Class I (*b*) no plantings were made in 1905–6, inasmuch as it was not deemed that sufficient data were at hand upon which to select the wheats to introduce into the centgener system of rigid selection for improvement, but numerous varieties have been subjected to preliminary selection for two seasons and systematic notes taken as to their field characteristics and apparent adaptability to California conditions to serve as a basis for the selection of the varieties for improvement. The following stocks, after having been under observation at this Station for two seasons, have been determined upon as a basis upon which to begin the centgener work at Yuba City:

CLASS I (*b*). GRAINS SELECTED FOR CENTGENER PLANTINGS AT YUBA CITY, 1906–7.

C. I. No.	Name.
	Wheats.
1437.	Crimean
1494.	Arnautka
1587.	----------
2089.	Richi
2239.	Beloglina
----	White Australian
----	Salt Lake Club
----	Sonora
----	Propo
----	English Master
----	Mediterranean
V.A.C.206.	St. Land

C. I. No.	Name.
	Oats.
274.	Lawinger
292.	----------
441.	Danish
445.	White Tartar
	Barleys.
190.	Beldi
257.	Tennessee Winter
---	Common California

The above varieties will hereafter be planted in the centgener plats according to the following scheme, and will also be planted in the field each year to establish an accurate average against which to measure whatever improvement may take place.

THE PLAN FOR NURSERY BREEDING.

The plan for nursery breeding for improvements of the chosen varieties deals with individual parent plants, and the progeny therefrom so planted, one seed in a hill, that their yield and other facts of actual performance may be recorded and compared so that only the best may serve as mother plants, and that a definite pedigree can be built up. The soil condition should be made as good as possible with the common tools, and the general environment of the plant should be as near as possible to those which can be obtained in good farming. In this way the plants selected will have proven best under the conditions in which they will be later grown in the field. The plats are to be seeded with the Minnesota centgener seeder at Modesto, and by means of a dibble at Yuba City, one plant in a hill.

The First Year.—Since it is desired to get as strong mother plants as possible for the future work, the foundation bed of 1906–7 wherever possible will be 1,200 plants of each of the nursery varieties. When the

plants have made a few inches growth the hills that may have two plants are carefully thinned to a single plant. The nursery beds are kept free from weeds by hand pulling or hoeing. The grain is deemed ripe when it is in the *hard*-dough stage. At this time the smaller plants are gradually cut out until only 100 of the apparently strongest yielders remain. In deciding upon the 100 plants preference should be given to plants having nearly the same height, bearing well-filled heads. The heads are removed from each of these plants separately and those from each plant placed in an envelope, furnished for this purpose. The bunches of spikes from each variety are to be sent to Berkeley, where they will be weighed, and all but the 25 weighing the most, discarded. These 25 are now shelled out by hand and the net weight of grain and its quality determined. These data now serve as the basis for selecting the 12 plants giving the highest net weight as centgeners for the succeeding season.

The Second Year.—One of the prime objects is to secure plants of the highest breeding power, consequently a centgener plat (100 seeds) from each of the twelve selected plants is planted with the machine. When ripe, 12 of the apparently most productive plants are selected, the heads removed and placed in the envelopes, the heads from each plant being placed in one envelope, the data filled in according to the printed form and sent to Berkeley. The remaining number of plants are to be counted, the necessary centgener notes taken, after which the grain is threshed and weighed. From these data the average yield per plant is obtained, which shows the average yield of the progeny of the respective mother plant originally selected.

The Third and Fourth Years.—In each of these years some of the best seed from each plat are planted and selection practiced as before. The average yield for the three annual tests of 300 progeny of each of the hundred mother plants indicates the breeding power. From those that have shown the best results a few are now selected for promotion to field trials in competition with the parent variety, or others there growing.

The Fifth Year.—During this year the seeds are multiplied to secure sufficient seed for the field trial.

The Sixth to the Eighth Years.—During these years the varieties are continued against the parent and other field varieties, and those which make good as strong yielders during the entire series of years are those worthy of distribution.

The Ninth and Tenth Years.—During these years the seed can be distributed for trial elsewhere and also continued on the station. The seed may also be increased for distribution and large milling tests.

CLASS I (*c*). HYBRIDS.

The plantings under this subdivision have to deal with wheats that have been developed by crossing varieties either on our own stations or elsewhere. The work of crossing was begun the past season, the larger number of crosses having been made at the Yuba City station. The main object involved in the crosses made this season was the combination of some of the high gluten wheats with the strong, upright-growing sorts commonly grown in California. With the hope of holding the field characteristics of the latter, in-crosses and out-crosses were made both with the hard winter varieties and the durums that had shown desirable characteristics.

A list of the crosses made at Yuba City is subjoined.

TABLE III. LIST OF CROSSES MADE AT YUBA CITY, CAL., 1906, GIVING NUMBER OF GRAINS OBTAINED FROM EACH CROSS.

FEMALE PLANT.			MALE PLANT.		Number of Grains Obtained.
Number.	Name.		Name.	Number.	
----	Salt Lake Club	x		2899	11
----	Salt Lake Club	x	Kubanka	2246	43
----	Salt Lake Club	x	Pootung	1704	11
----	Salt Lake Club	x	Galgalos	2398	31
----	Salt Lake Club	x	Bluestem	----------	40
----	Salt Lake Club	x	Kubanka	----------	22
----	Salt Lake Club	x	White Australian	----------	14
----	Salt Lake Club	x	Chul	2227	12
----	Salt Lake Club	x	Velvet Don	2247	7
----	Salt Lake Club	x	Richi	2089	51
----	Salt Lake Club	x	Pererodka	1350	12
----	Salt Lake Club	x	Fretes	1596	46
----	Salt Lake Club	x	Yellow Gharnovka	2096	18
----	Salt Lake Club	x		2394	6
----	Salt Lake Club	x		2825	1
1494	Arnautka	x	Salt Lake Club	----------	7
2093	Berberisco	x	Salt Lake Club	----------	4
2899		x	Salt Lake Club	----------	63
682	Early Japanese	x	Bluestem	----------	20
2899		x	Bluestem	----------	47
1772	Spelt	x	Bluestem	----------	8
1494	Arnautka	x	Bluestem	----------	7
1597	Medeah	x	Bluestem	----------	14
2495	Red Winter Wheat	x	Bluestem	----------	7
2247	Velvet Don	x	Bluestem	----------	17
1184–1	Japanese No. 1	x	Bluestem	----------	5
1184–2	Japanese No. 1	x	Bluestem	----------	11
2398	Galgalos	x	Bluestem	----------	67
1596	Fretes	x	Chul	2227	27
2832	Tuscan	x	Fultz	1923	6
1772	Spelt	x	Spelt	1772	2
----	White Australian	x	Salt Lake Club	----------	12
V.A.C. 205	Japhet	x	White Australian	----------	11
K 647	Onigara	x	White Australian	----------	19
1772	Spelt	x	White Australian	----------	21
2091	Albacete	x	White Australian	----------	5
2398	Galgalos	x	White Australian	----------	17
2528	Algerian Durum	x	White Australian	----------	3
2702		x	White Australian	----------	2
2830		x	White Australian	----------	18
2832	Tuscan	x	White Australian	----------	12
----	Bluestem	x	Spelt	1772	14
----	Bluestem	x	Medeah	1597	1
----	Bluestem	x	Yellow Gharnovka	2096	16
----	Bluestem	x		73	2
----	Bluestem	x	Bluestem	----------	11

TABLE III.—*Continued.*

Female Plant.			Male Plant.		Number of Grains Obtained.
Number.	Name.		Name.	Number.	
----	Bluestem	x	Salt Lake Club	----	4
----	Bluestem	x	Velvet Don	2247	12
----	Bluestem	x	Kubanka	2246	21
----	Bluestem	x	Chul	2227	12
----	Bluestem	x	Richi	2089	31
----	Bluestem	x	Fretes	1596	17
2398	Galgalos	x	Galgalos	2398	22
2398	Galgalos	x	Fultz	1923	16
2398	Galgalos	x	Tuscan	2832	7
2398	Galgalos	x	Spelt	1772	24
----	Kubanka	x	Salt Lake Club	----	33
----	Kubanka	x	Fretes	1596	4
----	Kubanka	x	Chul	2227	18
----	Kubanka	x		2899	44
----	Kubanka	x	King's Early	5079	46
1595	Kahla	x	Kubanka	----	0
1596	Fretes	x	Kubanka	----	63
2899	----	x	Kubanka	----	40

FIG. 4. Making crosses of wheat at Yuba City.

Kansas Hybrids.—Besides the crosses made at the stations, sixty-six hybrids developed at the Kansas station were grown at Yuba City station, all in row plantings. They were seeded January 20th to 22d and had germinated by February 5th. The stand of most of them was fair. Most of these hybrids have proven themselves worthy of another trial, but a few of them have been discarded. The tabulation which follows is of those which have made the best showing:

TABLE IV. KANSAS HYBRID PLANTINGS, GIVING THE MOST FAVORABLE RESULTS AT YUBA CITY—SEASON 1905-6.

C. I. No.	Name.	Common or Durum.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless.	Tenacity.	Stools.	Average Grains Per Head.	Calculated Number of Grains Per Plant.
1791-1	Big English x Turkey	c	Sp	151	100	a	100	2-3	40	100
1791-2	do	c	Sp	152	100	b	100	2-3	40	100
1795-1	Farquhar x Turkey	c	Sp	151	100	b	100	2-4	32	96
1795-2	do	c	Sp	151	100	b	100	2-3	27	67
1795-4	do	c	Sp	151	100	a	100	1-3	50	100
1797-2	Red May x Pesterboden	c	Sp	151	100	b	100	2-3	32	80
1798-1-1	Red May x Weissenberg	c	Sp	151	100	a	100	1-3	36	72
1798-2	do	c	Sp	149	100	b	100	4	58	232
1798-3	do	c	Sp	149	100	a	100	3-4	43	147
1799-1	Red May x Turkey	c	Sp	149	100	a	100	3-4	42	147
1800	Pesterboden x Red May	c	Sp	149	100	b	100	3-4	28	98
1801-2	Currell x Pesterboden	c	Sp	149	100	b	100	2-4	36	108
1801-3	do	c	Sp	149	100	a	100	2-4	44	132
1802-2	Currell x Banat	c	Sp	149	99.5	b	100	3-4	34	119
1802-3	do	c	Sp	149	99	a	100	2-3	38	95
1840-1	Andrews No. 4 x Turkey	c	Sp	148	99.5	b	100	1-3	42	84
1840-2	do	c	Sp	150	100	b	100	3-4	38	133
1842	Big English x Turkey	c	Sp	150	100	b	100	2-3	44	110
1870-1	Thiers x Currell	c	Sp	153	100	b	100	2-3	26	65
1903-2	Zimmerman x Turkey	c	Sp	153	100	b	100	2-4	34	102
1904-2	do	c	Sp	153	100	b	100	2-3	38	95
1905-1	Turkey x Jones' Winter Fife	c	Sp	153	99	b	100	2-3	40	100
1906-1-2	do	c	Sp	150	100	a	100	3-4	40	140
1906-2	do	c	Sp	151	100	b	100	4	40	160
1908-3	do	c	Sp	146	99.5	a	100	1-3	44	88

c—common; Sp—spreading; b—bearded; a—awnless.

There are few, if any, of these which seem to have any advantage in field characteristics over the standard varieties in the field plantings. In most cases these did not mature as early as those in the field plantings. They have not, however, been under trial for a sufficient time to give anything like a fair idea of their worth. They will be under trial another season before entering any of them in the field section.

U. S. D. A. Hybrids.—Seventy-two hybrids from the United States Department of Agriculture were also under trial, all of which reached maturity. These were seeded in rows 12 inches apart, January 12th to 17th, and cultivated throughout the season on account of the large number of weeds which developed in the plats. All of these were seeded too late to obtain the best results. In most cases they are spreading in character, thus partaking of the nature of the winter varieties, and as previously indicated will have to be grown upon clean summer-fallow land to make good under our conditions.

The results from the most promising varieties are shown in tabular form below:

TABLE V. Department Hybrid Plantings Giving the Most Favorable Results at Yuba City—Season 1905-6.

C. I. No.	Name.	Common or Durum.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless.	Tenacity.	Stools.	Average Grains per Head.	Calculated Number of Grains Per Plant.
4a7-1-2-1	Onigara x Ghirka Winter	c	Sp	159	100	b	100	6	32	192
13a4-1-1-1	Crimean x Onigara	c	Sp	159	100	b	100	5	38	190
13a5-1-1-1	do	c	Sp	159	100	b	100	7	30	210
13b8-1-2-1	Crimean x Onigara	c	Sp	159	99	b	100	5	44	220
14a2-1-1-1	Onigara x Crimean	c	Sp	159	99	b	100	7	44	308
14a3-1-1-1	do	c	Sp	159	99	b	100	5	48	240
14b1-1-1-1	Onigara x Crimean	c	Sp	159	99	b	100	7	36	252
14b2-1-1-1	do	c	Sp	159	99	b	100	8	36	288
18b3-1-1-1	Diehl Mediterranean x Kubanka	c	Sp	159	99.5	b	100	7	46	322
18b4-1-1-1	do	c	Sp	159	100	b	100	8	38	304
21a6-1-1-1	Banat x 1383 (1181)	c	Sp	159	100	b	100	6	40	240
21a7-1-1-1	do	c	Sp	159	100	b	100	7	38	266
22a2-1-1-1	Japanese No. 4 x Diehl Mediterranean	c	Sp	159	100	b	100	6	38	228
22b3-1-1-1	do	c	Sp	159	100	b	100	4	40	160
24b2-1-1-1	1409 x Early Japanese	c	Sp	159	100	b	100	8	36	288
31a5-1-1-1	1406 x Diehl Mediterranean	c	Sp	159	100	b	100	8	36	288
31a6-1-1-1	do	c	Sp	159	100	b	100	9	38	342
31a7-1-1-1	do	c	Sp	159	100	b	100	8	42	336
31a8-1-1-1	do	c	Sp	159	100	b	100	9	36	324
31a9-1-1-1	do	c	Sp	159	100	b	100	7	34	238
31b4-1-1-1	do	c	Sp	159	100	b	100	6	46	276
32a4-1-1-1	1406 x 1405	c	Sp	159	100	b	100	6	54	324
132b-1-1-1-1	Yemide x Dawson's Golden Chaff	c	Sp	159	100	b	98	7	34	238
134a4-1-2-1	Crimean x 1406	c	Sp	159	100	b	100	8	40	320
144a4-1-1-1	Russian x Roshan	c	Sp	164	100	b	100	6	34	204
164a7-1-1-1	Jones' Winter Fife x White Richelle	c	Sp	159	100	b	100	6	32	192
168b7-4-1-1	Jones' Winter Fife x Dawson's Golden Chaff	c	Sp	159	100	b	100	5	58	290
168b7-4-1-2	do	c	Sp	159	100	b	100	5	58	290
174a5-1-1-1	Crimean x 1382 (1176)	c	Sp	155	100	b	99	7	28	196
195a5-1-1-1	Wellman's Fife x Kubanka	c	Sp	162	100	a	100	5	50	250
200b3-1-1-1	Banat x Yaroslav	c	Sp	160	100	b	100	6	52	312
330a2-1-1-1	(Unknown)	--	--	160	100	b	100	5	52	260
350a1-1-1-1	Turkey x Extra Early Oakley	c	Sp	160	100	b	100	3	40	120
362a2-1-2-1	Sea Island x (Yemide x Dawson's Golden Chaff)	c	Sp	160	100	b	100	5	40	200
362a4-1-1-1	do	c	Sp	160	100	b	100	6	46	276
365a2-1-1-1	Sea Island x (1408 x Japanese No. 4)	c	Sp	160	100	b	100	5	38	190
365a4-1-1-1	do	c	Sp	160	100	b	100	6	42	252

c—common; Sp—spreading; b—bearded.

CLASS II. FIELD PLANTINGS. YUBA CITY, 1905-6.

In the matter of field plantings in order to get a start in 1906 a number of varieties were selected which had given good results at a number of the other experiment stations of the country, and in the other coöperative experiments of the Department of Agriculture. These, together with the common California varieties, were sown on various sized plats in this class. Hereafter, however, no variety will be introduced into the field tests until it shall have demonstrated its right to such a place by a satisfactory showing in the preliminary row plantings, and those now introduced will be gradually narrowed by comparative tests until only the very best remain.

Out of a considerable number of field plantings only those tabulated below seem worthy to continue in this class. Some others will be introduced, however, for the next season. The weedy condition of the field, together with the fact that the seasonal conditions did not permit the planting of a number of the winter varieties sufficiently early to have them under the proper conditions, will account for the low yields. In a few cases the yields were not thought sufficiently accurate to include, although the general field conditions were such as to warrant a continuance of the variety in the field trials. Before really satisfactory tests can be made the land will have to be put in a cleaner condition than it is at the present time. It may be said that a strenuous effort is being made the present season to so clean the land of weeds that hereafter the winter wheats may not be at such a disadvantage against the upright growing ones.

TABLE VI. Field Plantings Giving the Most Favorable Results at Yuba City—Season 1905-6.

C. I. No.	Name.	Common or Durum.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless.	Tenacity.	Stools.	Average Grains Per Head.	Calculated Number of Grains Per Plant.	Yield Per Acre, in Bushels.
293/04	California Gem	c	E	150	99.5	a	100	3	64	192	
1437	Crimean	c	Sp	151	100	b	100	3	34	102	7.17
1595	Kahla	d	E	141	100	----	----	1-2	52	78	8.33
1596	Fretes	c	E	149	100	b	100	2-4	34	102	7.12
1698	Allora	c	E	130	100	partly b	100	1-3	38	76	8.17
1699	Canning Downs	c	E	125	100	b	100	2-4	42	126	7.00
1736	Iumillo	d	E	----	----	b	100	----	38	----	----
2089	Richi	d	E	141	100	b	100	1-2	62	93	14.50
2096	Yellow Gharnovka	d	E	141	100	b	100	1-2	52	78	----
2227	Chul	c	E	141	100	b	100	1-2	25	37	12.83
2239	Beloglina	c	Sp	144	100	b	100	1	30	30	----
2246	Kubanka	d	E	145	100	b	100	1-2	62	93	14.66
2247	Velvet Don	d	E	152	100	b	100	1-2	62	93	13.83
2398	Galgalos	c	Sp	139	100	a	100	1-4	22	55	12.00
2899	----	d	E	125	95	b	100	1-2	25	37	14.66
1746	King's Early	c	E	131	100	b	100	2	29	58	10.66
----	Fulcaster	c	Sp	143	97	b	97	1-2	25	37	5.66
----	Mediterranean	c	Sp	143	98	b	95	1-2	33	49	8.66
----	English Master	c	Sp	148	100	a	99	1-2	38	85	9.00
----	Bobs	c	E	137	100	a	100	1-3	42	84	8.66
----	Club	c	E	138	100	a	100	1-2	56	84	11.22
----	Bluestem	c	E	139	100	a	100	2-4	----	----	10.50
Minn.66	Power's Fife	c	E	143	100	a	100	2-3	62	155	----
V.A.C. 206	St. Land	c	E	145	100	a	100	1	57	57	----
----	White Australian	c	E	142	100	a	100	1-2	38	57	5.49

c—common; d—durum; E—erect; Sp—spreading; b—bearded; a—awnless.

From the above it will be seen that the low-spreading wheats gave results much too low to rank with the upright-growing common sorts; the average yield of the spreading varieties of winter wheats being but 8.60 bushels per acre, while the upright-growing varieties gave an average of 9.30 bushels. This difference in yield is no doubt due in part to certain external causes, which must be reckoned with annually in any attempt to grow this class of wheats. Among these causes are the uncertainty of being able to seed sufficiently early on land that has grown a cereal crop the year previous and the foul condition of the land. We can not regard results obtained in these experiments as at all conclusive until it is possible to free the land devoted to these comparative trials from weeds.

These difficulties can be overcome in a measure by putting the plats upon summer-fallow land, and it may prove that we shall have to follow this practice, for a time at least, in order to get satisfactory tests with these spreading varieties.

It is doubtless true that all these wheats will do much better after becoming acclimated in California. This year against our common wheats they were at considerable disadvantage in this respect.

The durums used in field plantings in most cases surpassed the common wheats by notable amounts, the average yield being 13.19 bushels per acre as against 9.30 bushels for the upright-growing varieties, and surpassing the Salt Lake Club by 4½ bushels per acre.

CLASS III. SPECIAL EXPERIMENTS.

The experiments under this class have been planned for the purpose of trying out some of the mooted questions relative to cereal culture, in addition to the main study of problems relating to the apparent gradual loss of gluten in wheats that are introduced here and the cause of the relatively low gluten content of the wheats which are grown in the State as compared with the same varieties grown in certain other states. All these special experiments were begun in the season of 1905–6, and for this reason the results stated below can only be looked upon as a mere record of work under way, and no attempt is made to draw conclusions. This can only be done after more extended work.

Experiment A. Fertilizers for Wheat.

Much has been said by millers and others as to the reduced fertility of the wheat soils in the regions represented by the two stations, and the effect of the deterioration upon the quality of wheat produced. To gain some definite information along this line and to study the effect of various combinations of plant food, especially nitrogen, as affecting the gluten content of the wheats, a series of fertilizer trials is being conducted.

The material used on each of these plats was prepared by thoroughly pulverizing and mixing. In the case of the nitrate of soda, one-half of the amount was used in the winter, January 3, 1906, after plowing, and at once disked and harrowed in, and the remainder was applied to the growing grain on April 7, 1906. All plats were prepared at the same time and in all respects subjected to the same treatment. The plats were seeded with Salt Lake Club wheat at the rate of 72 pounds per acre on January 23, 1906. The size of the plats devoted to these trials is one-twentieth of an acre.

These plats are expected ultimately to answer not only the question as to whether there will be an *absolute* increase in the yield, but also whether this increase, if any be obtained, can be secured at a profit from the ordinary materials in the market. Further, analyses of the grain grown upon these plats for a series of years are expected to show what, if any, is the effect of the materials used upon the quantity and quality of the gluten.

TABLE VII. Results of Experiment A. Yuba City, 1905-6.

Fertilizer Used.	With Lime.			With Lime (132½ lbs. hydrated).		
	Plat No.	Spring Condition	Yield Per Acre: Bushels	Plat No.	Spring Condition	Yield Per Acre: Bushels
No fertilizer (check)	15	Yellowish green	10.66	16	Yellowish green	9.33
6 lbs. sulfate of potash 10 lbs. nitrate of soda	19	Dark green	8.33	20	Green	20.66
30 lbs. dissolved bone-black 6 lbs. sulfate of potash	23	Dark green	12.33	24	Light green	17.00
30 lbs. dissolved bone-black 10 lbs. nitrate of soda	27	Dark green	20.33	28	Green	17.33
30 lbs. dissolved bone-black 6 lbs. sulfate of potash 10 lbs. nitrate of soda	31	Dark green	15.00	32	Dark green	19.33
No fertilizer (check)	33	Yellowish green	13.66	34	Light green	15.33
26½ lbs. Thomas phosphate 6 lbs. sulfate of potash 10 lbs. nitrate of soda	35	Dark green	18.00	36	Pale green	9.33
30 lbs. ammoniated bone superphosphate	39	Green	13.33			

Experiment B. Rotation.

There is a definite need of systematically conducted experiments to ascertain positively the wisdom of the practice of bare summer-fallow in cereal culture. To continue it in regions where it is not absolutely essential is certainly a suicidal policy, and one which is losing vast sums to the State in wasted opportunity. Especially is this true since it has been quite conclusively shown by the Experiment Station of Minnesota

that the practice of such bare fallow leads to the oxidation of organic matter to such an extent that sufficient nitrates are developed to supply four or five crops of wheat, but that these nitrates are practically all lost in the drainage water in the following winter.

This actual burning up of the humus of the soil, especially in semi-arid regions, is one of the most woful wastes of California agricultural practice. This is the more true since in the semi-arid regions *moisture is the all-important factor of crop production* and the bare-fallow system steadily and surely reduces the amount of organic matter in soils and thus their moisture-holding power. Soils rich in humus can produce maximum crops with much less precipitation than those which are deficient. Thus any system of farming in dry sections which tends to lower the percentage of organic matter inevitably courts disaster.

Very pertinent to this is an experiment described by Professor Cavanaugh, of Cornell Experiment Station. He undertook the analysis of soil from an orchard where three successive crops of crimson clover had been plowed under. In order to learn what change, if any, had been produced, another sample from the same field, but where no clover had grown, was also examined. These two samples were taken about 20 feet apart, and there was no reason to suppose that previous to the growing of the clover, the soil in these two places was materially different. The amounts of moisture, humus and nitrogen, were determined.

The results were as follows:

	With No Clover Per Cent.	After Clover Per Cent.	Difference.
Moisture	8.75	15.00	6.25
Humus	1.91	2.94	1.03
Nitrogen	.12	.21	.09

Possibly a more definite idea may be had of these differences if the increased amounts per acre are calculated. Since the soil was in an orchard, where the extreme depth of cultivation was about 6 inches, the samples were taken to that depth. The average weight of soils per acre for a depth of 6 inches is about 750 tons, or 1,500,000 pounds; 6.25 per cent of this amount, in the case of moisture, would show an increased water-holding capacity of 93,750 pounds, or 46⅞ tons. This result was made possible by the increased amount of humus, and a careful system of surface tillage. If there had been no other benefit from this system of green-manuring than this increased power to hold moisture, it would have more than paid for seed and labor, for an extra 46 tons of water is very convenient in a dry time, and might possibly be the turning point between success and failure.

Already the wheat soils of the San Joaquin Valley have had their humus content so seriously impaired as to render it extremely doubtful if it is at all possible to produce three good successive crops of wheat upon the same land, largely on account of their lack of moisture-holding power. This is not equally true of the heavier soils represented by the

Yuba City station. On the former lands, then, rotation experiments reduce to finding a remedy for a condition already induced by continued bad practice. This is one of the problems embraced in the cereal investigation. Some crop must be found to grow in winter alternating with wheat and other cereals to increase the humus, and thus not only enable a better cereal crop to be grown with the same precipitation, but also enable us to replenish the depleted nitrogen. Some leguminous crop that will make a winter growth must be found. To this end the rotation experiments are laid out upon each station.

The plan involves essentially a two-year rotation, as appears in the following scheme:

TABLE VIII. Plan of Rotation Plats for Coöperative Experiments in California.

First Year.	Second Year.	Third Year.	Fourth Year.
1. Wheat	Wheat	Wheat	Wheat.
2. Wheat	Fallow	Wheat	Fallow.
3. Fallow	Wheat	Fallow	Wheat.
4. Horse Bean (turned under).	Wheat	Horse Bean (turned under).	Wheat.
5. Wheat	Horse Bean (turned under).	Wheat	Horse Bean (turned under).
6. Canadian Field Pea (turned under).	Wheat	Canadian Field Pea (turned under).	Wheat.
7. Wheat	Canadian Field Pea (turned under).	Wheat	Canadian Field Pea (turned under).
8. Wheat	Wheat	Wheat	Wheat.
*9. Horse Bean (turned under). Kaffir Corn	Wheat	Horse Bean (turned under). Kaffir Corn	Wheat.
10. Wheat	Horse Bean (turned under). Kaffir Corn	Wheat	Horse Bean (turned under). Kaffir Corn.
11. Rye and Vetch (turned under).	Wheat	Rye and Vetch (turned under).	Wheat.
12. Wheat	Rye and Vetch (turned under).	Wheat	Rye and Vetch (turned under).

Experiment C. Change of Seed.

There is a widespread idea among growers that a frequent change of seed is desirable, or even essential, to good crop production. Work already done along this line by other stations has cast much doubt upon the wisdom of such change.† The favorable conditions for conducting such an experiment between the two stations, and the extent of the practice among California wheat-growers, were thought to warrant its introduction into this general scheme of special experiments.

The scheme devotes two plats of one-twentieth acre each to this work. One plat is to be continuously devoted to one variety of seed; the other is to have its seed changed each year with that of the other station. The seed used in these trials is Salt Lake Club. The object sought is a comparison of the yield between the two plats.

* These plats not used at Modesto.

† Bulletin No. 181, California Experiment Station, pp. 165–169.

Experiment D. Tendency toward Constancy of Change to Starchy Conditions, and Effect of Time of Cutting on Composition of Wheat.

There is a special need in California for a type of wheat adapted to our soils and climate which carries a much higher gluten content than any now grown, in order that we may supply from our home product all the demand for milling wheat. For many years the station has introduced gluten wheats for trials, but on the limited scale of operation no variety has been found which did not within a few years show a decided reduction in gluten content and an apparently corresponding increase in starch.

The experiment has for its object a search for the cause of such change in order that we may the better determine the means of controlling it.

It is particularly desirable to know whether or not this tendency to change is constant; whether it is due to climatic conditions, the time of cutting, the bleaching action of the sun, or some induced or inherent condition of the soil. It is proposed to study all these points, as well as others that may suggest themselves in connection herewith. During the season of 1905–6 special attention has been directed to the influence of the time of cutting, or more specifically the effect on the gluten content of the grain by cutting it in the hard-dough stage as is done in the Eastern States instead of allowing the grain to become over-ripe and very dry as is the practice here with the combined harvester. While but a single season's work is recorded, yet in this experiment because of the large number of samples used, and since the samples cut in any one season must be compared only with others of the same variety grown in the same season under identical conditions except for the time of harvest, the results may be considered as giving a very fair indication as to whatever effect may be attributed to either practice. This, however, will not apply to the matter of *constancy* of change, but only to the effect of the time of cutting. The former will require a series of seasons before data will be at hand for comparison, although the data secured this season are of decided interest.

This experiment is divided into several parts, each having a special object in view.

Part 1 contemplates determination of the constancy of change in wheat from a glutenous to a starchy condition over a series of years on the same wheats grown under the same field conditions. There is also contemplated a determination of the seasonal influence upon such change. As a point of departure for the experiment, three varieties of wheat grown in California the previous season, each showing a number of more or less starchy variations from the type selected, were chosen, and each was separated into several types of grains, as indicated in the subjoined table:

TABLE IX. Showing Physical and Chemical Deviation from Type—Yuba City, 1905–6.

C. I. No.	Name.	Character of Seed.	Date of Harvest.	Per Cent of Typical Grains.	As Analyzed.				Calculated to Dry Matter.		
					Moisture.	Total Nitrogen.	Albuminoids.	Ash.	Total Nitrogen.	Albuminoids.	Ash.
2221	Kubanka	Clear	*Original*	100.00	9.99	2.10	11.96	1.83	2.33	13.12	2.13
2221	Kubanka	Clear	July 2	55.60	10.11	1.92	10.92	2.04	2.14	12.12	2.26
2221	Kubanka	Clear	Aug. 13	52.10	10.26	1.83	10.36	2.08	2.03	11.56	2.32
2221	Kubanka	Spotted	*Original*	0.00	10.21	1 81	10.27	1.88	2.03	11.56	2.09
2221	Kubanka	Spotted	July 2	50.80	10.38	1.82	10.36	1.98	2.03	11.56	2.21
2221	Kubanka	Spotted	Aug. 13	44.10	10.31	1.78	10.11	1.95	1.99	11.32	2.19
2221	Kubanka	Starchy	*Original*	0.00	9.45	1.66	9.41	1.84	1.72	9.77	2.03
2221	Kubanka	Starchy	July 2	63.50	10.30	1.89	10.76	2.02	2.11	12.04	2.25
2221	Kubanka	Starchy	Aug. 13	61.70	10.28	1.88	10.68	2.06	2.09	11.88	2.29
2227	Chul	Dark	*Original*	100.00	10.27	2.05	11.64	1.84	2.28	13.39	2.05
2227	Chul	Dark	June 30	59.40	10.50	1.81	10.27	1.99	2.03	11.56	2.22
2227	Chul	Dark	Aug. 13	63.00	10.67	1.81	10.27	1.98	2 02	11.48	2.22
2227	Chul	Spotted	*Original*	0.00	10.67	1.73	9.80	1.90	1.61	9.13	...
2227	Chul	Spotted	June 30	76.80	10.31	1.94	11.00	2.00	2.17	12.36	2.12
2227	Chul	Spotted	Aug. 13	65.10	10.65	1.78	10.11	1.88	1.99	11.32	2.10
2227	Chul	Light	*Original*	0.00	10.42	1.44	8.17	1.77	1.61	9.13	2.99
2227	Chul	Light	June 30	52.00	12.49	1.87	10.64	2.00	2.12	12.04	2.28
2227	Chul	Light	Aug. 13	62.30	12.43	1.82	10.36	1.94	2.06	11.72	2.22
L. No. 338A	Turkey	Clear	*Original*	100.00	12.74	1.59	9.05	1.74	1.71	9 71	1.99
L. No. 338A	Turkey	Clear	July 7	65.30	10.41	1.77	10.03	1.87	1.98	11.25	2.09
L. No. 338A	Turkey	Clear	Aug. 13	69.60	10.40	1.78	10.11	1.91	1.98	11.25	2.13
L No. 338B	Turkey	Starchy	*Original*	0.00	12.34	1.42	8.09	1.72	1.62	9 20	1.96
L. No. 338B	Turkey	Starchy	July 7	67.30	10.15	1.77	10.03	1.97	1.97	11.20	2.19
L. No. 338B	Turkey	Starchy	Aug. 13	50.10	10.41	1.78	11.11	1.94	1.98	11.25	2.17

The above table indicates that for the past season there was a slight decrease in the gluten (albuminoids) in the late cutting as against the earlier, but that this was very small from a practical standpoint. Just what influence the seasonal conditions may have had upon this change can not be said. In most instances it will be noted that the chemical analysis corresponds with the count based upon the physical appearance of the grains. This is especially true in the case of Kubanka 2221, in which case the difference in the physical appearance of the grains was very marked and easily observed. In the case of Chul 2227 the difference in the physical appearance of the grains was often quite difficult to detect, which may explain, in a measure at least, the apparent discrepancy. The chemical analyses given are the result of triplicate determinations which gave essentially the same results.

Part 2 of this experiment contemplates following the percentage of change on the same varieties of wheat each year for a series of years and comparing this change with the climatic conditions for the same period. Several varieties of wheat were selected, and the percentage of typical grains (*i. e.* those that during the previous season had remained true to type) was determined, as indicated in column 4 of the table, this determination being made upon 1,000 grains of the wheat. At the end of the season the count was made upon the progeny, the idea being that if there was a decidedly constant tendency toward change to the starchy condition then there should be annually a decreasing number of typical grains, and if the start was made with a high gluten wheat, a gradual lowering of the gluten content would take place until it approached the condition of the wheats now grown in the State.

To ascertain also the effect of the time of cutting, two cuttings of each of the varieties was made, the first being while the grain was in the hard-dough stage, while the second cutting was made when the grain was in the condition that generally obtains when the combined harvester is used. The results are presented below:

TABLE X. Showing Seasonal Percentage Variation of Wheat and Effect of Time of Cutting—Yuba City, 1905-6.

C. I. No.	Name.	Date of Harvest, 1906.	Per Cent of Typical Grains, 1905.	Per Cent of Typical Grains, 1906.	As Analyzed.				Water-Free.		
					Moisture.	Total Nitrogen	Albumin-oids.	Ash.	Total Nitrogen.	Albumin-oids.	Ash.
212/02	Fretes	June 30	50.8	100.00	10.10	2.02	11.48	2.10	2.25	12.80	2.34
212/02	Fretes	August 13	50.8	100.00	10.37	2.06	11.72	2.05	2.30	12.68	2.29
1442	Kharkov	July 10	37.5	93.1	10.47	2.13	12.12	2.15	2.38	13.68	2.40
1442	Kharkov	August 13	37.5	88.7	10.46	2.08	11.80	2.08	2.32	13.32	2.23
1563	Weissenberg	July 10	15.8	87.7	10.04	2.09	11.88	2.18	2 32	13 32	2.42
1563	Weissenberg	August 13	15.8	79.1	10.10	1.95	11.04	2.17	2.16	13.26	2.41
1595		July 2	75.2	53.0	10.04	2.07	11.76	2.19	2.30	12.68	2.43
1595		August 13	75.2	79.0	10.09	2.62	12.84	2.22	2.52	14.31	2.47
2096	Yellow Gharnovka	July 5	....	15.3	11.28	1.55	8.80	2.02	1.75	9.94	2.78
2096	Yellow Gharnovka	August 13	....	9.0	11.09	1.53	8.70	2.01	1.72	9.77	2.26
2234	Kubanka	July 2	23.7	63.4	10.31	1.91	10.84	2.05	2.13	12.12	2.29
2234	Kubanka	August 13	23.7	71.8	10.57	2.13	12.12	2.20	2.38	13.68	2.46
2239	Beloglina	July 5	....	66.1	10.50	1.66	9.41	1.98	1.85	9.43	2.21
2239	Beloglina	August 13	....	59.9	10.49	1.81	10.27	2.00	2.02	10.28	2.23
2247	Velvet Don	July 2	93.8	79.5	10.05	2.02	11.98	1.95	2.25	13.74	2.17
2247	Velvet Don	August 13	93.8	78.2	10.04	2.03	11.56	1.89	2.26	13.73	2.10

In the above table one of the interesting points is that instead of a decreasing number of typical grains as indicated by the physical appearance, there was in general an increase in 1906 over 1905, indicating, if the physical appearance is always a reliable method of judging of the character of the grain, that the change toward the starchy condition is not a constant but a fluctuating one, probably governed much in the case of any given variety by the seasonal factor. Here again it is indicated by the season's crop that the time of cutting after the grain has reached the hard-dough stage had but little if any influence upon the gluten content, for in only four out of eight cases did the earlier cutting show a higher percentage of albuminoids; and even in these cases the larger amount was not sufficient to give the earlier cut grain any practical advantage over that cut later, a point also shown in Table IX.

Experiment G. Effect of Change of Environment on Composition of Wheat.

The purpose of this experiment is to determine the effect of the change of environment upon the chemical and physical characteristics of wheat. Both common and durum wheats are being used in these trials. In the former case the Hays, Kansas, and the Amarillo, Texas, cereal stations are coöperating with the Yuba City station, Crimean 1437 being the wheat used in the trials. In this experiment there is an annual interchange of seed between the Yuba City station and the other coöperating stations, the same variety being grown from local seed each year at the several stations. The yields per acre and the chemical and physical character of the grains from the local and interchanged seed are annually compared.

The experiment with durum wheat is conducted with Kubanka 2246, and the coöperating stations are Hays, Kansas, and Highmore, South Dakota.

THE MODESTO CEREAL STATION, 1905-6.

The station comprises twenty acres of land of a silty nature located about four miles east of Modesto, near what is known as the Waterford road. During the season of 1905–6 about fourteen acres were devoted to plat work, the remainder being summer-fallowed for the crop of 1906–7.

During the autumn of 1905 the rain came very late, so that plowing was not commenced until December 6th. As the surface had been doubled-disked after the previous crop had been taken off, the soil was in very good shape to absorb the moisture as soon as it came.

Preparation of the Soil.—The plowing was done to a depth of about 6 inches with a 14-inch walking plow, while the soil was still quite dry. On account of the lateness of the season it was not deemed advisable to delay longer. However, the soil was put into a fair condition, but the under soil was not as compact as advisable for a cereal crop in this locality.

The month of December was quite cool and the climatic conditions poor for germinating the seed, consequently many of the varieties did not germinate for more than a month after seeding, and in many plats the percentage of germination was quite low. In the case of the larger plats seeded with a drill the 60 pounds of seed used proved too small a quantity for the most satisfactory results. Under favorable conditions for germination and stooling 60 pounds per acre might prove sufficient upon summer-fallow land, but to meet all emergencies we are inclined to favor a heavier seeding.

As at Yuba City the season proved altogether too late for satisfactory results with such varieties as Kharkov, Turkey, and Crimean.

On the San Joaquin Valley station it will be necessary to summer-fallow, especially when the winter varieties are planted, and it is altogether probable that this will prove true with other varieties if any satisfactory yields are obtained.

SUMMARY OF PLANTINGS AT MODESTO, 1905–6.

Standard varieties of common and durum wheats	370
U. S. Department of Agriculture hybrids	72
Kansas hybrids	66
Barleys	127
Oats	22
Spelt	1
Rye	3
Emmer	2
Einkorn	1
Corn	1
Total	665

The general scheme adopted at Modesto is the same as that at Yuba City.

CLASS I. NURSERY PLANTINGS, MODESTO, 1905–6.

Class I (a).—Of the plantings under this class the following table presents the important features of the more promising varieties:

TABLE XI. STANDARD, ROW PLANTINGS GIVING THE MOST FAVORABLE RESULTS AT MODESTO—SEASON 1905-6.

C. I. No.	Name.	Common or Durum.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless.	Tenacity.	Stools.	Average Grains per Head.	Calculated Number of Grains per Plant.
	Zimmerman	c	Sp	145	100	a	94	2-3	36	90
682	Early Japanese	c	Sp	143	100	b	96	2-3	36	90
1181	Japanese No. 4	c	E-Sp	141	100	b	85	2-3	28	70
1184-1	Japanese No. 1	c	Sp	144	100	b	90	2-3	28	70
1442	Kharkov	c	Sp	155	100	b	90	3-4	28	98
1494	Arnautka	d	Sp	154	100	b	98	2	40	80
2/05	Chilean Wheat	d	E	150	100	b	98	3	44	132
212/02-1	Fretes	c	E	146	100	b	95	4	34	136
1698	Allora	c	E	146	100	a	94	3-4	36	126
1699	Canning Downs	c	E	146	100	b	95	3-4	32	112
1732	Fish Head	c	E	143	100	b	90	3-4	40	140
1733	Dawson's Golden Chaff	c	E	151	100	a	93	3-4	48	168
1746	King's Early	c	E	144	100	b	92	3-4	34	119
2124-3	Hurma	d	Sp	145	100	b	90	2-3	30	75
2126-1	Kurd	c	Sp	142	100	b	90	3	32	96
2126-2	Kurd	d	Sp	142	100	b	90	4	32	128
2191	Diminum	c	E	146	100	b	95	4	40	160
2200-1	Karun	c	E	142	100	a	95	3-4	32	112
2200-2	Karun	c	E	142	100	b	95	3-4	34	119
2201-2	Buetha	c	E	142	100	b	95	3-4	32	112
2203-1	Koola	d	E	143	100	b	95	4	34	136
2203-2	Koola	c	E	142	100	b	95	4	36	144
2203-3	Koola	d	E	143	100	b	95	4	38	152
2204	Humera	c	E	142	100	b	95	4	36	144
2209	Abundance	c	Sp	153	100	a	96	2-3	40	100
2210	Cap Sheaf	c	Sp	153	100	b	94	3	46	138
2211	Early Windsor	c	Sp	152	100	--	--	3-4	----	----
2212	Early Ontario	c	Sp	151	100	a	92	4	36	144
2213	Mogul	c	Sp	152	100	a	92	3-4	32	112
2214	Winter King	c	Sp	152	100	a	--	2-3	40	100
2235	Marouani	d	E	145	100	b	--	4	32	128
2397	Red Winter	c	Sp	146	100	b	--	4	36	144
2404	Iantagbay	c	E	145	100	b	--	4	32	128
2405	Kisilbugda	c	E	152	100	b	--	4	32	128
2503	Ble dur Ada	c	E	140	100	b	--	6	32	192
2506-1	Ble demi dur Ada	c	E	140	100	b	--	6	32	192
2507-1	Ble qualite de vente courante	c	E	140	100	b	--	6	32	192
2508	Ble violet Choa	c	E	140	100	b	96	6	34	204

2510	Emmer	dicoccum	E	140	100	b	97	7	36	252
2511-1	Agat-Lse-Ssilarse	c	E	140	100	b	95	5	36	180
2511-2		c	E	140	100	b	92	6	36	216
2512-1	Emmer	dicoccum	E	140	100	b	96	7	32	224
2512-2	Emmer	dicoccum	E	140	100	b	96	8	36	288
2537	Algerian durum	d	E	152	100	b	99	3	26	78
2545	Algerian durum	d	E	152	100	b	98	3	28	84
2546		d	E	152	100	b	98	3-4	34	119
2547		d	E	152	100	b	98	3	40	120
2575		d	E	152	100	b	96	3	36	108
2691		d	E	156	100	b	--	3	38	114
2695		c	E	152	100	b	93	3-4	38	133
2702		c	E	154	100	a	90	3-4	38	133
2708		c	E	154	100	b	90	4	34	136
2720		c	E	154	100	b	88	3-4	36	126
2723		c	E	155	100	b	87	3-4	32	112
2747		c	E	151	100	b	91	3-4	36	126
2751		c	E	154	100	b	84	3-4	38	133
2794	Rebeiro	d	E	150	100	b	96	3-4	28	98
2796		d	E	147	100	b	95	3	38	114
2799-1		c	E-Sp	145	100	a	94	2-3	32	80
2800		d	E	147	100	b	96	2-3	36	90
2801-1		c	E-Sp	145	100	a	96	3	32	96
2802-1		c	E-Sp	144	100	a	96	2-3	28	70
2803		c	E-Sp	143	100	b	95	3	28	84
2808		c	E-Sp	149	100	b	92	3	32	96
2811		c	E	141	100	--	--	3	--	---
2813		d	E	151	100	a	95	3	40	120
2814		d	E	149	100	b	95	3	40	120
2815		c	E-Sp	148	100	b	90	3-4	32	112
2816		c	E	147	100	b	95	3-4	32	112
2817		c	E-Sp	147	100	b	--	3-4	--	----
2821	Defiance	c	E	151	100	a	95	4-5	40	180
2828		c	E	154	100	b	98	1-2	40	60
2830		c	E	150	100	a	94	3	40	120
2832	Tuscan	c	E	150	100	a	93	3	36	108
2888	Filippino	d	E	152	100	b	93	3-4	42	147
2891		d	Sp	154	100	b	97	3-4	36	126
----	Purple Straw	c	E	151	100	a	98	3	48	144
----	Early Baart	c	E	142	100	b	97	3	48	144
----	Philippine	d	E	153	100	b	96	4	36	144
V. A. C. 205	Japhet	c	E	156	100	a	94	3	34	----
V. A. C. 206	St Land	c	E	156	100	a	96	3	40	----
V. A. C. 209	Dattel	c	E	156	100	a	96	3	36	----

c—common; d—durum; E—Erect; Sp—Spreading; b—bearded; a—awnless.

Class I (b), Modesto.—Upon the basis set forth in previous pages of this bulletin the following named grains have been selected for centgener plantings at Modesto 1906–7, and the plan set forth on pages 281–282 will be followed for their improvement by selection:

Wheats.

1181.	Japanese No. 4	2507.	(From New Zealand)
1442.	Kharkov	293/04.	California Gem
1494.	Arnautka		Early Baart
1596.	Fretes	V. A. C. 207.	Schiddam
1698.	Allora	V. A. C. 208.	Samaur de Mars
1732.	Fish Head	Minn. 66.	Power's Fife
1746.	King's Early	Minn. 163.	Glyndon
2227.	Chul		Australian (1906)
2246.	Kubanka		Club (S. L.)
2247.	Velvet Don		Propo (1906)
2397.	Red Winter		Sonora (1906)
2398.	Galgalos		Rice

Barleys.

			Oats.
194.	Telli	337.	Algerian
195.	White Smyrna	339.	Appler Rust Proof
	Chevalier	442.	Dun
	Common California	451.	----------
			California

Class I (c), Modesto.—A number of crosses of high gluten wheats upon our common stocks from selected plants were made at Modesto this year, the complete list being set forth in tabular form below. These hybrids will be used as the basis for selection and further work in hybridizing. The list of crosses made at the Modesto station follows:

TABLE XII. List of Crosses Made at Modesto, Cal., 1905–6, Giving Number of Grains Obtained from Each Cross.

Female Plant.			Male Plant.		Number of Grains Obtained.
Number.	Name.		Name.	Number.	
212/02	Fretes	x	Club	----	9
----	Club	x	Fretes	212/02	18
1494	Arnautka	x	Club	----	25
----	Club	x	Arnautka	1494	32
1558	Turkey	x	Club	----	12
----	Club	x	Turkey	1558	9
----	Bluestem	x	Fretes	212/02	7
----	Fretes	x	Bluestem	----	15
----	Bluestem	x	Arnautka	1494	1
1494	Arnautka	x	Bluestem	----	11
----	Bluestem	x	Turkey	1558	21

Kansas Hybrids at Modesto.—Sixty-six of the Kansas hybrids were grown at the Modesto station, all in row plantings. They were seeded December 11, 1905, but in most cases germination did not take place for at least a month. The final stand obtained was good, but the vigor only fair. On March 6th the plants were still all very small and those of spreading nature had made no upright growth at all. Although both season and soil conditions were decidedly against the best growth of these hybrids, a number of them give promise of being desirable wheats. Below is presented a tabulation of some of the more promising.

TABLE XIII. KANSAS HYBRID PLANTINGS GIVING THE MOST FAVORABLE RESULTS AT MODESTO—SEASON 1905-6.

C. I. No.	Name.	Common or Durum.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless	Tenacity.	Stools.	Average Grains Per Head.	Calculated Number of Grains Per Plant.
1789-2	Zimmerman x Turkey	c	Sp	154	100	b	92	2-3	38	95
1790-4	Currell x Weissenberg	c	Sp	154	100	b	92	2-3	30	75
1791-1	Big English x Turkey	c	Sp	154	100	a	93	2-3	32	80
1795-1	Farquhar x Turkey	c	Sp	154	100	b	90	2-3	36	90
1795-4	Farquhar x Turkey	c	Sp	151	100	a	95	2-3	32	80
1801-3	Currell x Pesterboden	c	Sp	152	100	a	92	1-2	32	48
1802-2	Currell x Banat	c	Sp	154	100	b	92	1-2	32	48
1802-3	Currell x Banat	c	Sp	153	100	a	93	2	32	64
1803-2	Currell x Theiss	c	Sp	154	100	b	85	2	32	64
1804-2	Tasmanian Red x Zimmerman	c	Sp	154	100	b	92	2	28	56
1806-2	Andrews No. 4 x Zimmerman	c	Sp	154	100	b	95	2	32	64
1807-1	Weissenberg x Currell	c	Sp	152	100	b	90	2	40	80
1808-1	Red May x Banat	c	Sp	152	100	a	92	2	26	52
1809-3	Red May x Theiss	c	Sp	152	100	b	90	2	32	64
1823-1	Penquite's Velvet Chaff x Zimmerman	c	Sp	154	100	b	90	2	36	72
1824	Zimmerman x Turkey	c	Sp	154	100	b	90	1-2	32	48
1826-2	Big English x Turkey	c	Sp	152	100	b	88	2-3	28	70
1832-2	German Emperor x Turkey	c	Sp	153	100	b	88	2-3	36	90
1833-1	Penquite's Velvet Chaff x Zimmerman	c	Sp	143	100	a	95	3	36	108
1833-3	Penquite's Velvet Chaff x Zimmerman	c	Sp	152	100	b	93	2-3	32	80
1842	Big English x Turkey	c	Sp	153	100	b	85	2-3	32	80
1845-2	Zimmerman x Tasmanian Red	c	Sp	153	100	b	92	2-3	38	95
1845-3	Zimmerman x Tasmanian Red	c	Sp	152	100	a	95	2-3	36	90
1845-4	Zimmerman x Tasmanian Red	c	Sp	152	100	b	90	2-3	36	90
1848	Bearded Monarch x Turkey	c	Sp	152	100	b	92	2-3	44	110
1850-2	Dawson's Golden Chaff x Turkey	c	Sp	152	100	b	92	2-3	32	80
1851-2	Zimmerman x Theiss	c	Sp	153	100	b	91	2-3	50	125
1908-4	Turkey x Jones' Winter Fife	c	Sp	153	100	b	87	1-2	40	60

c—common; Sp—spreading; b—bearded; a—awnless.

U. S. D. A. Hybrids.—Seventy-two of the Department hybrids were seeded, of which number thirty-one failed to mature. They were all seeded in rows on December 11–12, and were cultivated throughout the season with a hand cultivator. The results of the most promising ones are tabulated on page 305.

CLASS II. FIELD PLANTINGS AT MODESTO, 1905-6.

In general, the same remarks as made under the corresponding head for Yuba City will hold for the field plantings at Modesto. The yields were in all cases very low—lower than at Yuba City. On page 306 is a table showing varieties that made the more favorable showing.

There are a few varieties of which special mention should be made. These are Fretes 1596, Red Winter 2397, Minn. 66, Minn. 163, Galgalos 2398, Ventura Agricultural Co. 207 and 208, Velvet Don 2247, Yellow Gharnovka 2096, Chul 2227, Kubanka, and Early Baart. Although none of these were high in yield, they made a favorable showing and are worthy of further field trial. The general appearance of these varieties was good throughout the season, their yield as compared with other varieties good, and the appearance of the grain after threshing, favorable. Early Baart was especially favorable on account of the quick growth. All of the durums made a favorable showing.

The following list of grains were determined upon for introduction into the field tests under Class II:

1437.	Crimean	Dietz Amber
1494.	Arnautka	Rice
1558.	Turkey	Mealy
1561.	Theiss	Early Pearl
1580.	Girgeh	Minn. 66. Power's Fife
1596.	Fretes	Minn. 163. Glyndon
1597.	Medeah	Minn. 169. Haynes' Bluestem
1698.	Allora	Minn. 146. Bolton's Bluestem
1699.	Canning Downs	Gold Coin
1704.	Pootung	English Master
1746.	King's Early	Philippino
1733.	Dawson's Golden Chaff	V. A. C. 208. Saumaur de Mars
2096.	Yellow Gharnovka	V. A. C. 209. Dattel
2227.	Chul	Early Baart
2239.	Beloglina	Bobs
2246.	Kubanka	Little Club (S. L).
2247.	Velvet Don	Sonora (1906)
2337.	Black Emmer	Australian ((1906)
2391.	------- -----	Propo (1906)
2397.	Red Winter	Washington Bluestem
2398.	Galgalos	Golden Gate Club
	Red Russian	

TABLE XIV. Department Hybrid Plantings Giving the Most Favorable Results at Modesto—Season 1905-6.

C. I. No.	Name.	Durum or Common.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless.	Tenacity.	Stools.	Average Grains per Head.	Calculated Number Grains per Plant.
13a-7-1-1-3	Crimean x Onigara	c	Sp	152	100	b	87	2	36	72
13b-8-1-2-1	do	c	Sp	152	100	b	94	2	32	64
14a-2-1-1-2	Onigara x Crimean	c	Sp	152	100	b	93	2	40	80
14a-3-1-1-1	do	c	Sp	152	100	b	92	2	36	72
14b-1-1-1-2	do	c	Sp	156	100	b	98	1-2	--	--
31a-5-1-1-1	1406 x Diehl Mediterranean	c	Sp	154	100	b	90	2-3	20	50
31a-7-1-1-1	do	c	Sp	154	100	b	85	2-3	36	90
31a-8-1-1-1	do	c	Sp	156	100	b	90	3	24	72
31b-4-1-1-1	do	c	Sp	156	100	b	90	3	32	96
32a-4-1-1-1	1406 x 1405	c	Sp	156	100	b	95	3	32	96
350a-4-1-1-1	Turkey x Extra Early Oakley	c	Sp	156	100	b	88	2-3	30	75
350a-5-1-1-1	do	c	Sp	156	100	b	89	2-3	40	100
350a-6-1-1-1	do	c	Sp	156	100	b	85	2-3	36	90
350a-7-1-1-1	do	c	Sp	156	100	b	90	2-3	34	85
351a-2-1-1-1	Red Winter Fife x (Onigara x 1344)	c	Sp	156	100	b	91	3	32	96
355a-1-1-1-1	Crimean x (Bigha x Yaroslav Emmer)	c	Sp	156	100	b	91	3	32	96

c—common; Sp—spreading.

TABLE XV. FIELD PLANTINGS GIVING THE MOST FAVORABLE RESULTS AT MODESTO—SEASON 1905-6.

C. I. No.	Name.	Common or Durum.	Manner of Growth.	Days to Mature.	Rust Resistance.	Bearded or Awnless.	Tenacity.	Stools.	Average Grains Per Head.	Calculated Number Grains per Plant.
293/04	California Gem or Spring	c	E	154	100	a	96	2	48	96
1596	Fretes	c	Sp	150	100	b	93	3-4	38	133
2096	Yellow Gharnovka	d	Sp	142	100	b	98	1-3	40	80
2122	Velvet Don	d	Sp	153	100	b	98	3	38	114
2227	Chul	c	Sp	144	100	b	--	3	32	96
2247	Velvet Don	d	Sp	142	100	b	98	1-3	46	92
2397	Red Winter	c	E	146	100	b	--	4	32	128
2398	Galgalos	c	Sp	147	100	a	90	3	--	--
Minn. 66	Power's Fife	c	Sp	154	100	a	93	3	38	114
Minn. 163	Glyndon	c	Sp	153	100	a	95	2-3	40	100
V.A.C.207	Schiddam	c	E	152	100	a	85	3	30	90
V.A.C.208	Saumaur de Mars	c	E	152	100	a	87	3	32	96
2826	Bobs	c	E	152	100	a	85	3	--	--
----	English Master	c	Sp	152	100	a	96	3	40	120
----	Dietz Amber	c	Sp	149	100	b	95	2	36	72
----	Red Russian	c	Sp	143	100	a	95	1-2	40	60
----	Rice Wheat	c	E	147	100	a	95	2-3	32	80
----	Sonora	c	E	141	100	a	90	2-3	50	125
----	Club	c	E	147	100	a	98	2-3	44	110
----	Bluestem	c	E	152	100	a	92	3	40	120
----	White Australian	c	E	151	100	a	95	2-3	40	100
2234 or 46	Kubanka	d	E	152 & 154	100	b	--	2-3	46	115

c—common; d—durum; E—erect; Sp—spreading; b—bearded; a—awnless.

CLASS III. SPECIAL EXPERIMENTS, MODESTO, 1905-6.

Experiment A. Fertilizers for Wheat.

The material used on each of these plats was prepared by thoroughly pulverizing and mixing. In the case of nitrate of soda, one-half of the total amount was applied in the fall mixture, and the other half was used as a top dressing. On April 28th the plats were first seeded with Theiss 1561 wheat. On December 15, 1905, at the rate of 60 pounds per acre. This made such a poor stand that on February 26th the plats were thoroughly disked and seeded with Kubanka at the rate of 70 pounds per acre. The results are set forth below:

TABLE XVI. RESULTS OF EXPERIMENT A, MODESTO, 1905-6.

FERTILIZER USED.	Plat Number.	Yield per Acre: Bushels.
No fertilizer (check plat)	1	7.66
6 lbs. sulfate of potash	3	3.33
30 lbs. ammoniated bone superphosphate 6 lbs. sulfate of potash	5	2 66
30 lbs. ammoniated bone superphosphate 10 lbs. nitrate of soda	7	8.33
30 lbs. ammoniated bone superphosphate 10 lbs. nitrate of soda 6 lbs. sulfate of potash	9	7.00
No fertilizer (check plat)	11	7.00
26½ lbs. Thomas phosphate 6 lbs. sulfate of potash 10 lbs. nitrate of soda	13	8.33
30 lbs. ammoniated bone superphosphate 6 lbs. sulfate of potash 10 lbs. nitrate of soda 132½ lbs. hydrated lime	15	12.66
132½ lbs. hydrated lime	17	7 00
30 lbs. ammoniated bone superphosphate	19	11.33
30 lbs acidulated bone black 6 lbs. sulfate of potash	21	9.66

Experiment B, Modesto, 1905-6.

This experiment was conducted along the same lines at Modesto as at Yuba City, certain of the varieties being the same in each place and others different. The results at Modesto are set forth in the following tables:

TABLE XVII. TABLE SHOWING PHYSICAL AND CHEMICAL DEVIATION FROM TYPE, MODESTO, 1905-6.

C. I. No.	Name.	Character of Seed.	Date of Harvest.	Per Cent of Typical Grains.	As Analyzed.				In Dry Matter.		
					Moisture.	Total Nitrogen.	Albuminoids.	Ash.	Total Nitrogen.	Albuminoids.	Ash.
2221	Kubanka	Clear	June 27	97.7	10.98	2.33	13.24	1.99	2 62	14 91	2.24
2221	Kubanka	Clear	July 31	88.7	10.95	2.10	11.96	1.90	2.36	13 40	2.13
2221	Kubanka	Spotted	June 27	88.0	10.87	2.31	13 16	1.98	2.59	14.75	2.22
2221	Kubanka	Spotted	July 31	69.7	10.90	1.98	11.24	1.94	2.22	12 60	2.18
2221	Kubanka	Starchy	June 27	95 3	10.95	2.23	12.68	1.89	2.50	14 20	2.12
2221	Kubanka	Starchy	July 31	100.0	----	2.37	13.48	----	----	----	----
2227	Chul	Dark	June 12	88.8	11.96	1.82	10.36	2.00	2.07	11 76	2.27
2227	Chul	Dark	July 31	80.8	10.10	1.63	9.25	1.84	1.81	10.27	2.05
2227	Chul	Spotted	June 12	87.2	11.13	1.96	11.16	2.00	2.21	12.56	2.25
2227	Chul	Spotted	July 31	90.0	11.09	2 15	12.20	1.95	2.42	13.76	2.19
2227	Chul	Light	June 12	76.0	11.23	1.91	10 92	1.90	2.15	12.20	2.14
2227	Chul	Light	July 31	63 2	(?)9.20	1.99	11.32	1.87	1.92	12.44	2.06
----	Turkey	Clear	June 27	95 9	11 28	2.08	11.80	2 08	2.34	13.32	2.34
----	Turkey	Clear	July 31	87.9	11.67	1.98	11.24	2.05	2.24	12.76	2.32
----	Turkey	Changed	June 27	91.1	11.19	1.98	11.24	2.02	2 23	12.64	2.27
----	Turkey	Changed	July 31	90.0	10.92	2.10	11.96	2.08	2.36	13.42	2.33
1558	Turkey	Original	June 27	----	10 33	2.16	12.28	2.02	2.40	13.63	2 25
1558	Turkey	Original	July 31	----	10.84	1.99	11.32	1 85	2.11	11.96	2.06
2246	Kubanka	Original	June 27	----	10.48	2 39	13.56	2.05	2.67	15.15	2.28
2246	Kubanka	Original	July 31	----	10.63	2 26	12.84	1.72	2.54	14.43	1.91

TABLE XVIII. Showing Seasonal Percentage of Variation of Wheat, and Effect of Time of Cutting—Modesto, 1905-6.

No.	Name.	Date of Harvest. 1906.	Per Cent Typical Grains. 1905.	Per Cent Typical Grains. 1906.	As Analyzed.				Calculated to Dry Matter.		
					Moisture. Per Cent.	Total Nitrogen. Per Cent.	Albuminoids. Per Cent.	Ash. Per Cent.	Total Nitrogen. Per Cent.	Albuminoids. Per Cent.	Ash. Pr. Ct.
212 02	Fretes	June 23	94.0	95.2	11.57	2.23	12 68	2.13	2.522	14 26	2.409
212 02	Fretes	July 31	94.0	93 0	11.65	2.22	12.60	2.17	2.513	14.26	2.456
2203	Koola	June 21	16.8	93.9	12.18	2.08	11.80	2.00	2.368	13.40	2.277
2203	Koola	July 31	16.8	87.5	12.28	2.19	12.44	2.02	2.497	14.10	2.303
2246	Kubanka	June 21	38.3	72.6	11.01	1.96	11.16	1.88	2.202	12 51	2.112
2246	Kubanka	July 31	38.3	66.7	11.13	2.12	12.04	1.96	2.228	12.59	2.205
2235	Marouani	July 14	43.2	93.1	11.50	2.15	12.20	1.98	2.429	13 71	2.237
2235	Marouani	July 31	43 2	96.0	11.67	2.30	13 08	2.05	2.604	14.72	2.321
2397	Red Winter	June 21	51 0	91.5	11.32	2.12	12.04	2.05	2.390	13 55	2.311
2397	Red Winter	July 31	51.0	88.0	11.43	1.88	10.68	2.06	2 122	12.04	2.323
2033	--	June 27	78.7	91.2	11.21	2.10	11.96	2.03	2.365	13.40	2.286
2033	---	July 31	78.7	95.3	11.04	2.29	13.00	2.06	2.556	14.51	2.299

An examination of these tables will reveal the fact that while there was an apparent slight decrease in the amount of albuminoids by allowing the grain to stand in the field for a month after it reached the hard-dough stage, yet this was not without exception in several cases, as for instance in the case of Chul 2227, spotted in part 1, where the early-cut grain carried 12.56 per cent albuminoids, and the late-cut carried 13.76 per cent; the same thing was again true in the case of Turkey changed. In part 2 of the same experiment this same thing is noticed in the case of Nos. 2203, 2235, and 2033. In the face of this number of cases, taken together with the same fact developed at the Yuba City station, it would seem that the change toward a starchy condition involves other factors than the matter of time of cutting after the grain reaches the hard-dough stage. The same experiment will be conducted for another season, and the work repeated at several stages of ripeness. For this reason the above analyses are merely set forth as tentative results, and the remarks made at this time may be subject to modification as other work is done.

Other experiments involving rotation of crops on wheat land, fertilization with legumes, change of seed, and the influence of quality of seed wheat on its progeny are also under way, but the short time they have been conducted prevents more than a mere mention of them at this time.

The results of each of these experiments will be duly published in bulletin form for distribution as soon as data of importance have been secured.

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UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
BERKELEY, CALIFORNIA

AGRICULTURAL EXPERIMENT STATION
E. J. WICKSON, ACTING DIRECTOR

CIRCULAR No. 30

(JUNE, 1907.)

WHITE FLY IN CALIFORNIA

BY C. W. WOODWORTH.

The white fly has at last become established in California. The most destructive insect in the citrus groves of Florida is this species of white fly, the *Aleurodes citri*. It is considered by the growers there as much more injurious than any of the scale insects attacking these fruits. Our trees were supposed to be free from the pest, but now

Figure 1.—The white fly on a leaf. Natural size.

a well established colony has made its appearance at Marysville at a center of travel by both steam and electric railways where the conditions seem particularly favorable to its spread over the State.

The seriousness of these facts to the citrus industry of this State renders it imperative that full publicity be given them in order that

the proper steps may be taken to meet this emergency. We are not sure that the insect is confined to this one locality. Every one who has trees should carefully inspect them and submit all suspicious specimens to some one capable of accurately identifying them. The Experiment Station will be glad to examine and report on any that may be submitted for this purpose. It may be entirely possible to eradicate an insect before it has become well established, but it will if allowed to increase become too widely distributed to effectively handle.

Many have been very apprehensive of the danger of introducing this insect from Florida and have been instrumental in having most stringent laws enacted preventing the importation of anything from that State liable to be infested, while others have maintained that the insect could not live in this climate at all. In support of this idea it has been claimed that the insect must have been introduced into the State many times on nursery stock before these laws went into effect and since that time on plants that escaped the attention of the inspectors. Many other species of white flies are able to live in California, however, including at least one injurious species. We do not have to speculate any longer on this matter since the insect in question is now not only existing here but thriving. Moreover, the insect is not appearing in the most humid parts of the State, but in the interior where the black scale is unable to thrive, that is, in a climate comparable to Riverside.

Though we now know that the white fly does live and thrive in our climate in the city of Marysville, there are those who still believe that our orchards are not menaced, still arguing on the basis of the climatic differences between California and Florida. The red scale, the black scale, and the purple scale are all Florida insects and have not found our climate impossible. Possibly the white fly may prove to be different, but it does not seem the part of wisdom to permit the white fly to have free access to our citrus orchards on the chance that it may not thrive there.

LIFE HISTORY.

The white fly must have been in California at least a full year judging by its distribution and abundance at Marysville, but no observations have been made on its life history and habits except during the last few weeks since its discovery in the State. There is but little doubt, however, that it will prove to be much the same as in Florida. The most elaborate study of this insect is that reported in Bulletin 67

of the Florida Experiment Station by Professor H. A. Gossard. In the following account of the insect much will be taken from this publication including the two plates illustrating the structure of the insect.

The Egg.—At the present time the insect is chiefly in the egg stage. These are shown very much enlarged in figure 2, which was photographed from a specimen collected at Marysville, and illustrates how

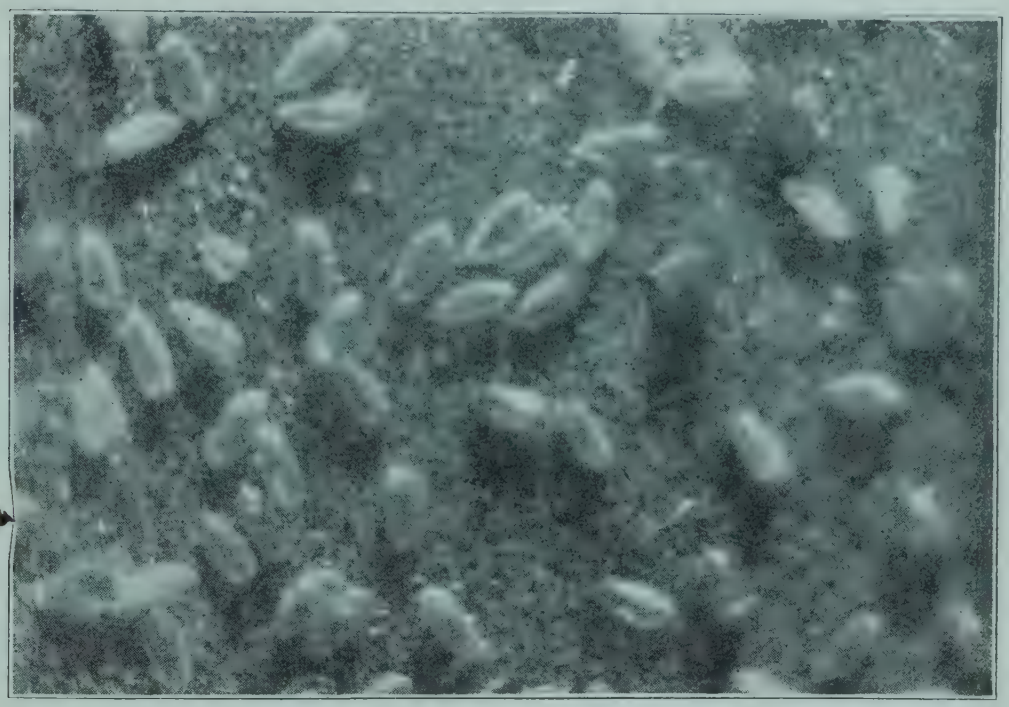


Figure 2.—Eggs of the white fly.

numerous they become. There were many thousands of such eggs on this leaf. Nearly every leaf on the trees in that part of town was similarly infested. These eggs are so small as to be scarcely visible to the eye singly, but the badly infested leaves appeared as though covered with mold. While rather less than half of the town of Marysville is badly infested, still a careful examination would show the presence of a few eggs on nearly every tree in town.

The eggs of the white flies are all very much alike and can be at once distinguished from every other known group of insects. The shape of the egg and of the stalk at the end by which it is attached to the leaf are sufficient to distinguish them. It is not, however, easy to distinguish between the eggs of the different species of white flies.

The presence of an egg of this character on the leaf of an orange or lemon is quite conclusive evidence of the presence of the destructive white fly of Florida.

According to Gossard, the egg requires from three to twenty days to hatch, according to the weather. In the hatching process the egg-shell splits in the manner shown in plate 1, figure 4.

The Nymph.—The young insect on hatching very much resembles a young scale insect, but can be readily distinguished by comparing a

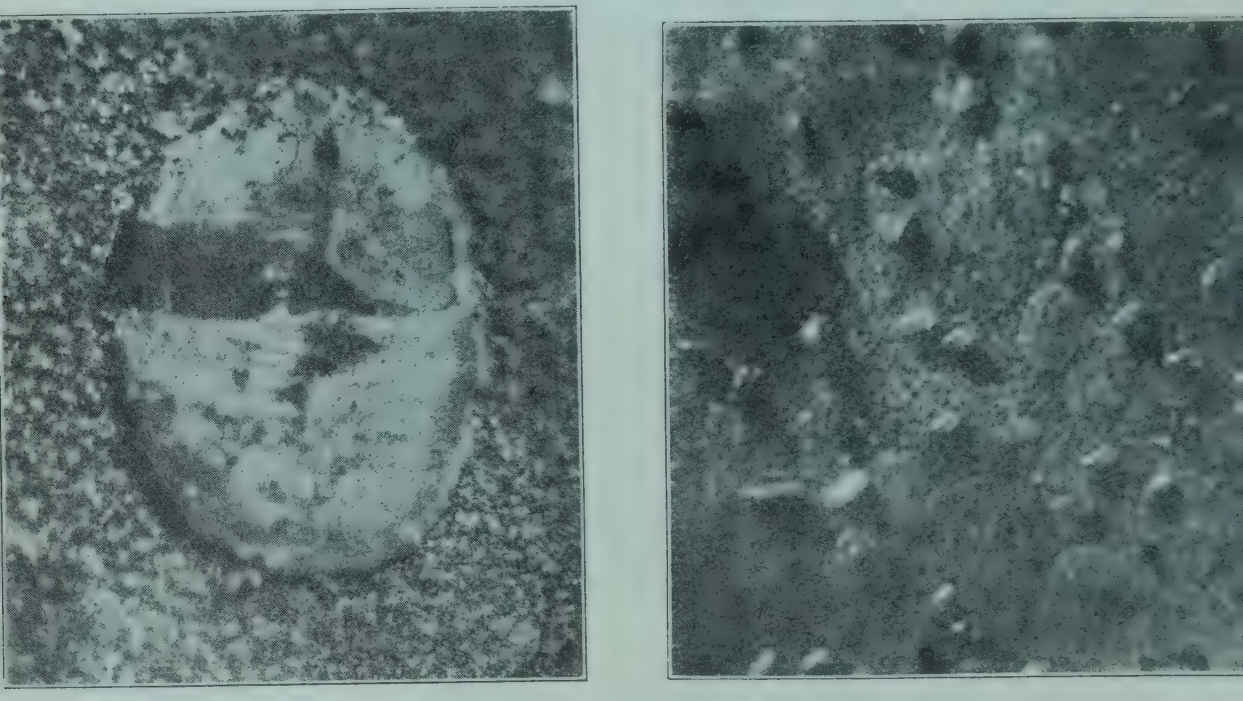


Figure 3.—Exuvium of the white fly and a young nymph.

carefully mounted specimen under a medium or high power of the microscope with the figure shown on plate 2, figure 1. Like the scale insects, the young white fly wanders over the twigs and leaves for a few hours, finally attaching itself by inserting its mouthparts into the leaf. After thus locating itself the young insect soon secretes a wax in sufficient quantity to fill the space between the body and the leaf. Because of the small size and transparency of the body and this cementing of the body to the leaf the insect is almost invisible. This makes it rather difficult to secure a good photograph of the insect. Figure 3 illustrates a partly grown nymph collected at Marysville produced from eggs laid this spring by flies appearing before the great majority had emerged.

In structure and habits the nymph is so like scale insects that if seen at all they could easily pass as young scales. It is not safe indeed to depend on the use of a hand magnifier for the identification of a young or partly grown nymph until one is thoroughly familiar with them, and even then the use of a compound microscope should be resorted to. The details of structure shown by a properly mounted microscopical preparation of the various stages is well shown on plate 2.

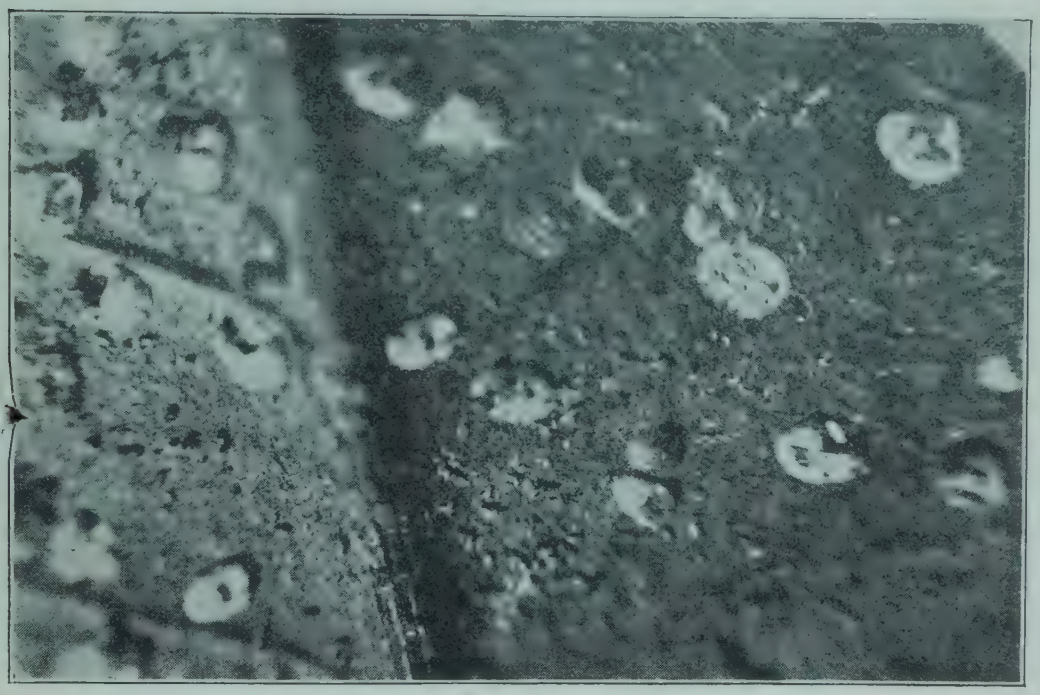


Figure 4.—White fly exuviae on leaf, much enlarged.

Within the body of the nymph during the last stage wings are developed in both sexes and the whole internal structure reorganized so that when the skin is finally cast off a slender bodied, delicate fly emerges. This is in striking contrast to the life history of scale insects where the male alone obtains wings. This makes the problem of the control of this insect entirely different and much more difficult than that of scale insects, as will be shown in the discussion of this subject below.

The full grown nymphs have a very much thicker skin than the younger stages and this remains attached to the leaf after the molt. This dried skin is very much more conspicuous than the living insect

and is the form illustrated in figures 1, 3, 4, 5, and 6. On some trees at Marysville most of the old leaves are well spotted over on the under side of these exuviae, as shown in figure 5.

The Adult Insect.—The name white fly was given to the insects of this class on account of the appearance of the adult insect. Its snowy white color makes the insect very conspicuous notwithstanding its extremely small size. In the spring they appear in great numbers for two or three weeks and then suddenly disappear after laying their

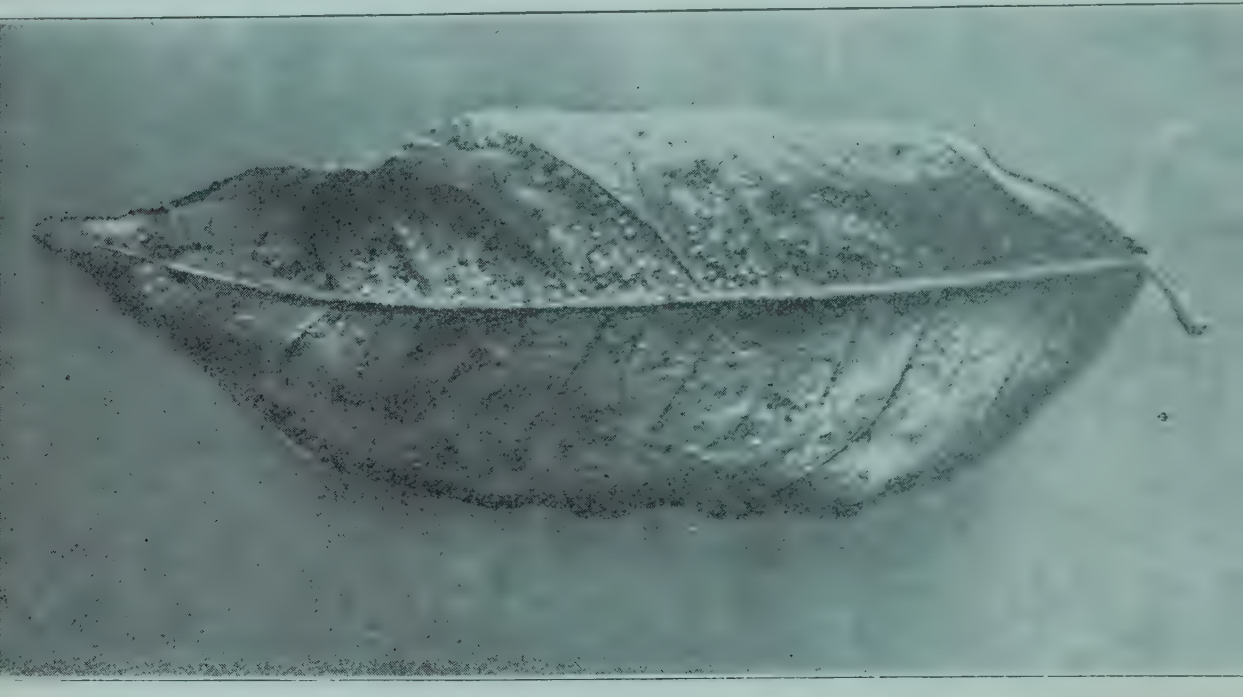


Figure 5.—Leaf showing dirty condition when badly infested.

eggs, only a very few belated individuals coming out after the others remaining in the trees. In mid-summer a second brood begins to appear. There is no distinct swarm as in the spring, but during the whole latter half of the year the adult white fly can be seen on the trees in greater or less abundance. After the colder weather of winter begins the adults almost entirely disappear and are not seen again until the spring emergence. The life of any individual fly is very brief, averaging, according to Gossard, between four days and a week. During this time the eggs are laid, and as many as seventy-five have been deposited by a single female.

EXPLANATION OF PLATE I.

Aleyrodes citri.

(This plate is reproduced from Bulletin No. 67 of the Florida Agricultural Experiment Station.)

Fig. 1.—Adult female, with expanded wings, much enlarged.

Fig. 2.—Adult female, with wings folded over the body in normal roof-like position.

Fig. 3.—Egg and foot-stalk of same, greatly magnified.

Fig. 4.—Egg-shell, showing the split through which the larva emerged.

Fig. 5.—Tip of male abdomen, showing claspers.

Fig. 6.—Antenna, showing annulated joints.

Fig. 7.—Fore margin of front wing.

Insects sometimes mistaken for *A. citri*:

Fig. 8.—Larva of *Aleyrodes floridensis*, greatly magnified.

Fig. 10.—Greatly enlarged section of waxen fringe, surrounding *A. floridensis.*

Fig. 11.—Outline of larva of *Lecanium hesperidum.*

EXPLANATION OF PLATE II.

(This plate is reproduced from Bulletin No. 67 of the Florida Agricultural Experiment Station.)

Aleyrodes citri.

Fig. 1.—Larva, first stage, greatly magnified.

Fig. 2.—Larva, first stage, drawn to same scale as figures 3, 4, 5, 8, 9, and 10.

Fig. 3.—Larva, second stage.

Fig. 4.—Larva, third stage.

Fig. 5.—Larva, fourth stage.

Fig. 6.—Margin of advanced larva, greatly enlarged.

Fig. 7.—Vasiform orifice of fourth larval stage, showing crenulated operculum with ligula in the center.

Fig. 8.—Pupa, showing embryo and distribution of orange-colored areas. Waxen tufts extending from the breathing tubes are shown.

Fig. 9.—Adult, with folded wings, emerging from the pupa case.

Fig. 10.—Empty pupa case, showing split through which the fly emerged.

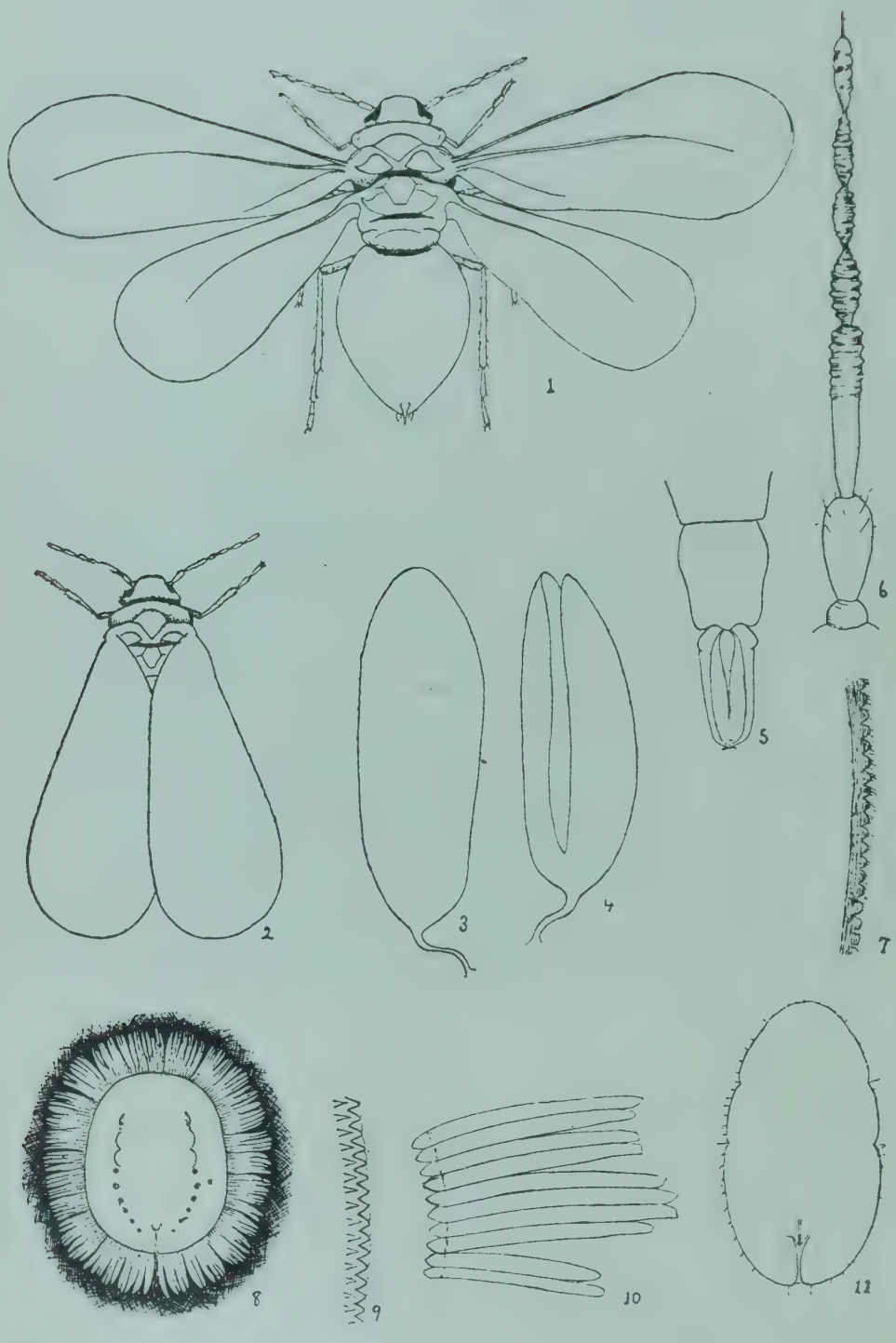


PLATE I.

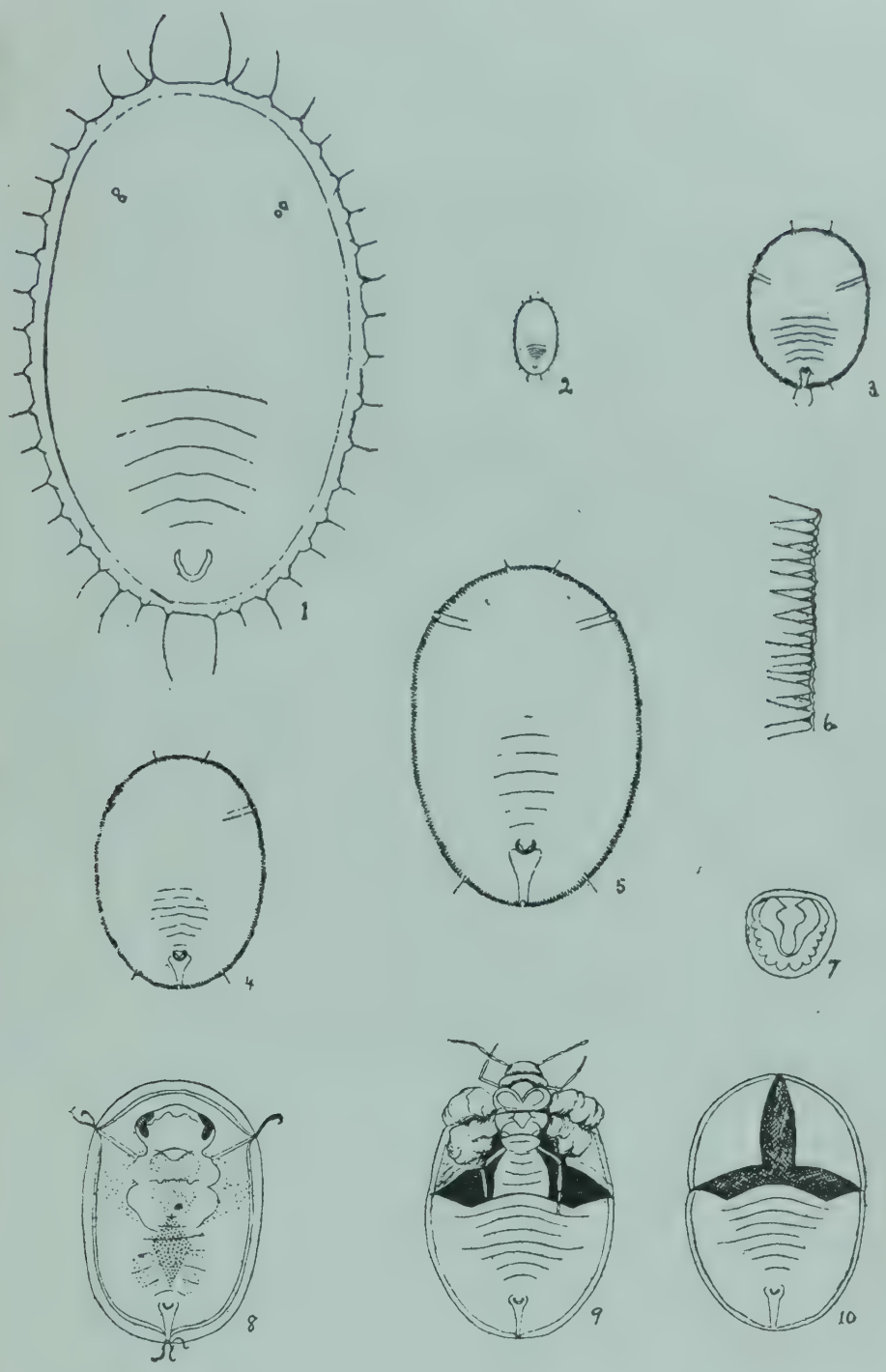


PLATE II.

THE DETECTION OF THE WHITE FLY.

At the present time the discovery of the presence of the white fly is of very great importance. After the insect has become so numerous that it is conspicuous either by its injuries or the swarms of the adult it is doubtful if eradication is possible, at least without very radical measures being employed. Much misapprehension can be avoided by getting a correct idea of the insect and of the things it is liable to be confounded with.

Figure 6.—Red scale, adult and young, and exuviae of white fly.

First it should be understood that the white fly is very minute. There is no other insect pest on citrus trees as small as the white fly, unless it be small individuals of the red or yellow scale. Figure 6 shows these two insects on the same leaf, and will give some idea of their relative appearance. The lighter spots are the exuviae of the white fly. There were a few young and eggs of this insect, but they could not be shown without magnification. The small dark spots are the young of the red scale. The structure of the scale is better shown in figure 7. The red or yellow scale occurs on the upper side of the leaf as well as below (see figure 8) and sometimes on twigs and fruit,

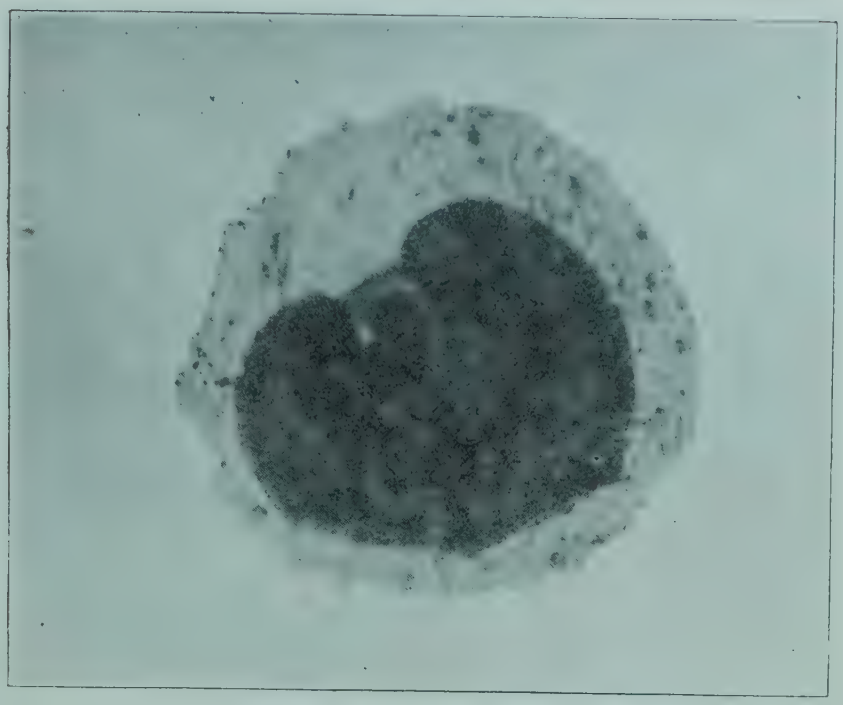


Figure 7.—Red scale, much magnified.

while the white fly confines itself exclusively to the leaves and almost exclusively to the under side of the leaves. No one will, however, confound these two insects if they see them clearly, for they are so

Figure 8.—Red scale on upper side of leaf.

Figure 9.—Red scale on leaf, much enlarged.

totally different in appearance. The comparison of figures 4 and 9 will show the differences that can be brought out by a hand magnifier between the exuvium of a white fly and the adult red scale, which might be confounded at first glance without the lens.

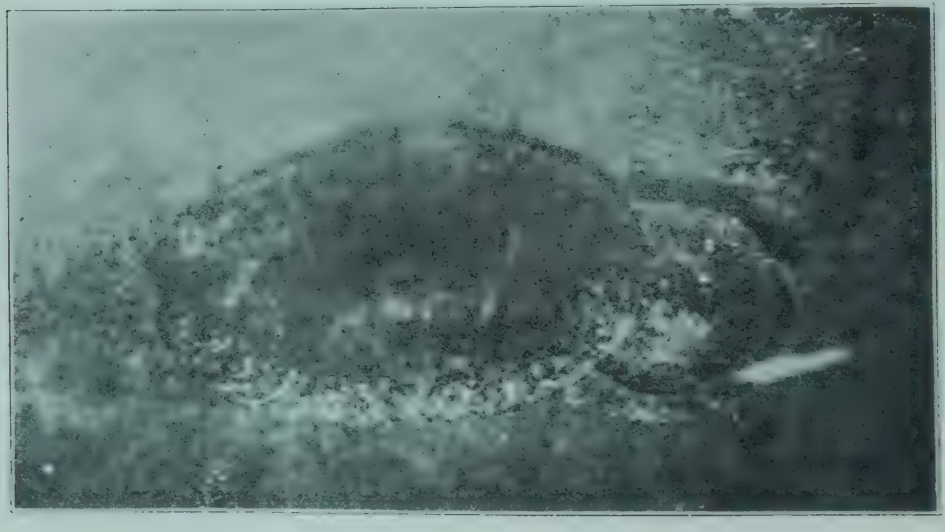


Figure 10.—Red and soft brown scale, much enlarged.

An insect much more likely to be confused with the white fly is the soft brown scale. This is a much larger insect than either the red scale or the white fly. Figure 10 shows about the smallest size of the adult; it is often more than twice as long. One can very easily mistake, however, a very young soft brown scale for a partly or fully grown nymph of the white fly. The soft brown scale is rarely as transparent as a white fly of the same size and is therefore much more easily seen. If one bends a leaf just beneath a young white fly he can generally succeed in causing the waxy cement that holds the insect to the leaf to

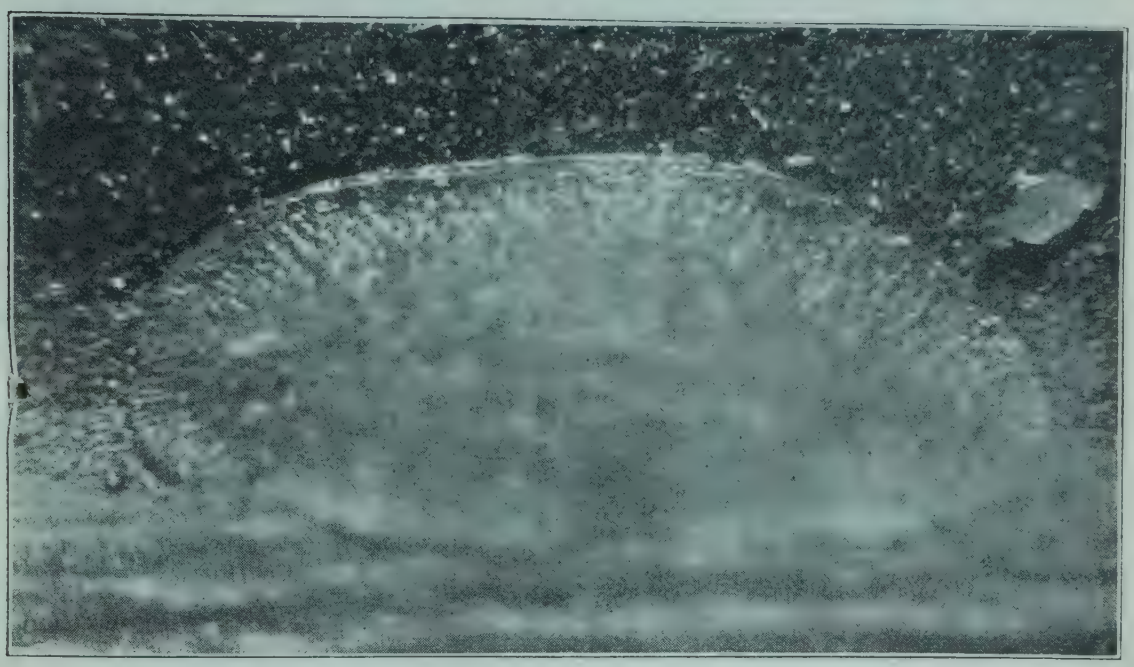


Figure 11.—The soft brown scale, much enlarged.

separate, allowing air to go beneath the insect, making it much more plainly visible, while no kind of manipulation produces such an effect on the soft brown scale. There will be many doubtful cases, however, where the compound microscope needs to be brought into use. When this is done a comparison with figure 11 of plate I and figures 1 to 8 of plate II will enable one to answer the question with absolute certainty.

There are many kinds of spots to be found on orange leaves which will be viewed with suspicion, all of which can be readily distinguished by the use of a good hand lens. We will figure only one of these, the nature of which is not generally understood. The small, active, dark

colored insects so common on orange trees, belonging to the family *Psocidae*, spin a small white silken covering for their eggs, as shown in figure 12. The white fly exists on the tree only in four forms: the egg, the nymph, the old finally discarded skin of the full grown nymph called the exuvium, and the active flying stage of the adult insect. All of these are illustrated in this circular. Any other kind of spot or structure on the leaf is certainly something else than the white fly.

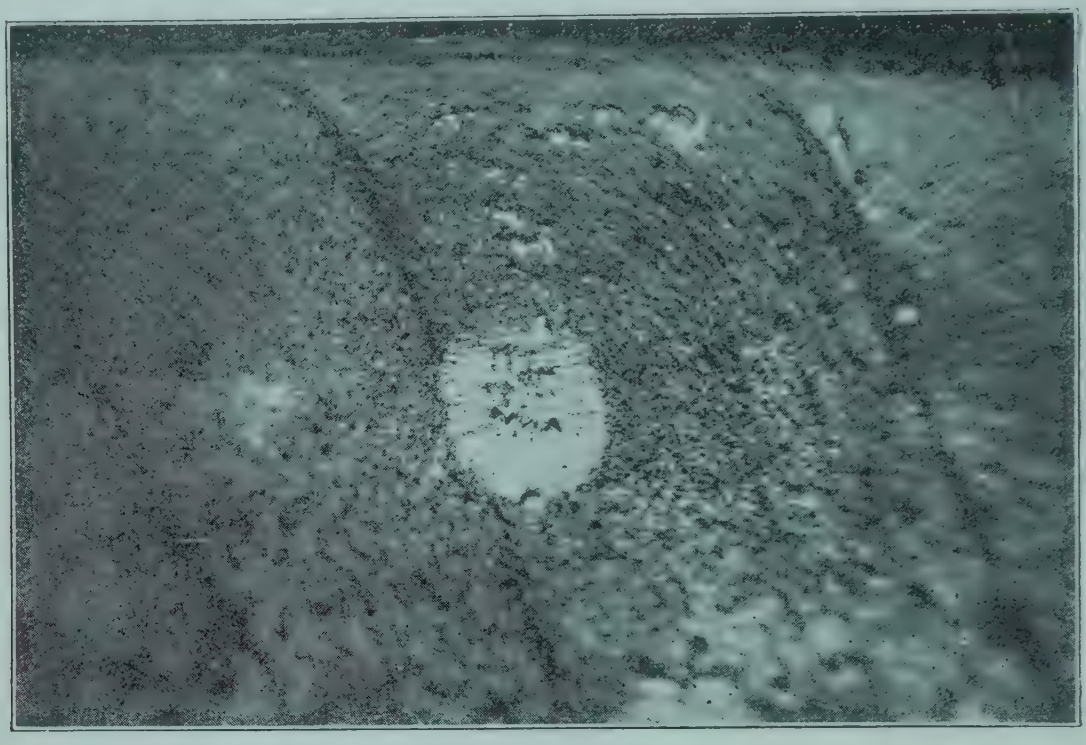


Figure 12.—Egg cocoon of a Psocid.

The means of distinguishing this species of white fly from other members of the same family is a rather difficult and complicated matter, but can be done by a careful comparison of the minuter details shown in plate II, especially in figures 5 and 8.

FOOD PLANTS.

The white fly seems to prefer the leaves of orange and lemon, but will come to maturity on quite a variety of plants. This greatly complicates the problem of their eradication or control. The following is a list of the plants upon which the insect breeds in Florida, as recorded by Gossard.

Citrus, all species.
China berry tree (*Melia azederach*).
Viburnum nudum.
Cape jessamine (*Gardenia florida*).
Japan persimmon (*Diospyros kaki*).
California privet (*Ligustrum amurense*).
Golden privet (*Ligustrum* sp.) .
Mock orange (*Prunus caroliniana*).
Ficus, various species.
Water oak (*Quercus aquatica*).
Prickly ash (*Xanthoxylum* sp.).

CHARACTER OF INJURY.

The injury done by the white fly is of exactly the same character as that done by scale insects, with the exception that being confined to the leaves there is no direct damage to the twigs and larger branches that makes the work of the San José scale, for instance, so fatal to the trees it attacks. Its direct effect on the foliage is similar to that of the red or purple scale and its indirect effect like that of the black scale. Doubtless this latter will be considered the more serious since the excretions of this insect seem to cause the smut to cling with so much tenacity that it is practically impossible to remove it.

METHODS OF CONTROL.

We have of course no experience in California in the control of this insect. The best Florida practice as recommended by Professor Gossard is as follows:

December—Spray with resin soap.
January—Spray with resin soap.
February—Spray again as above if necessary.
June—Spray with potash whale oil soap.
July—Spray with potash soap and sulfur.
August—Spray with potash soap and sulfur.
September—Spray with potash soap and sulfur.

Such a programme of spraying would seem rather hard to carry out to our growers, and possibly we might find that two or three fumigations a year would be as effective as the larger number of sprayings, or perhaps one fumigation followed by several summer sprayings. Our trees are mostly low and small as compared with the Florida groves, so that fumigation is possible as it would not be in that State.

None of the scale insects can fly, and therefore distribute themselves very slowly; but with the white fly in a community a clean orchard may become badly infested in a day, making summer treatment necessary no matter how thorough the winter work has been.

THE PRESENT PROBLEM IN CALIFORNIA.

As far as is known the white fly is still confined to the city limits of Marysville. There are no citrus orchards in the immediate neighborhood. Possibly therefore it may not have reached any other section. If let alone it certainly will reach every part of the State. The trees in the immediate neighborhood of the railroad tracks are now infested. The electric cars pass between infested trees going to the orange orchards of Butte county. Now, if ever, is the time to make an effort to destroy the pest. There is no possibility of throwing a quarantine around the infested district that a flying insect will respect. To delay all effort towards eradication till next winter, as seems now to be the programme, may be a fatal error. Every day during the latter part of the summer thousands if not hundreds of thousands of these minute creatures will be in the air capable of living long enough to be carried, in a car, the length of the State. A single one of these reaching a citrus district might make the eradication of the insect an impossibility. It may be that already the insect has gotten beyond control, but the chance of eradication is certainly worth the effort.

If eradication is to be attempted no half-way measures like spraying or fumigation are to be thought of. There is too much opportunity to miss some and no ready means of discovering the fact. A campaign of eradication should include: first, the immediate destruction of every leaf on all citrus trees in Marysville and of every other plant known to furnish sustenance to this insect; second, a thorough inspection of the new foliage as it comes out on the defoliated plants; third, an exhaustive search for other possible food plants of the white fly; fourth, redefoliation and persistent reinspection of any spots where the fly may not have been annihilated; fifth, careful inspection of every supposed case of white fly in the State; and finally competent scientific supervision of the work.

There will be very few adult flies produced during this month and the early part of July. After that the problem will be much greater and the chances of success correspondingly lessened. Will those most vitally interested see that the work is undertaken?

UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
BERKELEY, CALIFORNIA

AGRICULTURAL EXPERIMENT STATION
E. J. WICKSON, ACTING DIRECTOR

CIRCULAR No. 32

(JULY, 1907.)

WHITE FLY ERADICATION

BY

C. W. WOODWORTH.

Since the publication of Circular 30, "White Fly in California," by this Experiment Station, the insect has gone through another full generation. Very strenuous though misdirected efforts have been made towards its eradication, but the problem to-day is many fold more difficult, and the possibility of its suppression much more doubtful than a month ago.

A very large proportion of the insects have been destroyed through these efforts, but not one acre of infested territory has been cleared, and it requires just as thorough defoliation where there are but five white flies as though there were five thousand. Moreover, for the remainder of the summer, winged individuals will be continually coming forth, making the chances of its spreading to other localities a very serious matter.

We are now, therefore, confronted with a new set of conditions and should take a new view of the problem and prepare to meet the new conditions wisely, avoiding the mistakes of the past campaign.

What Has Been Done.

The white fly was discovered early in May, and the first work towards its eradication was done on the 22nd of June. The greater part of the defoliation, however, was done during the present month. How large the task was, one can have little conception from a cursory examination of the town. An examination of the map presented in this circular will enable one to get a comprehensive, though still inadequate, idea of its magnitude.

We have attempted in this map to show the location and present condition of every citrus tree in Marysville. The map is probably not absolutely accurate, since it was drawn from what could be made out without entering the lots, and very likely a few trees have been overlooked, but it will give a fair idea of the present situation.

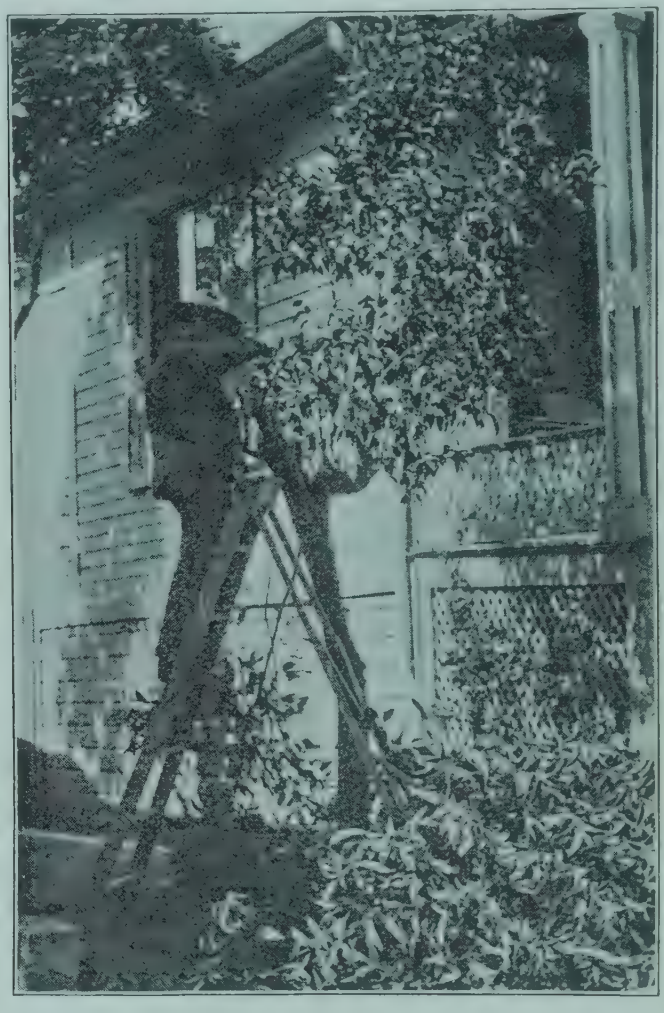


Fig. 1. The method of defoliation most commonly adopted.

Besides the citrus trees, we have indicated in this map the position of the electric and steam railways, because they may be supposed to afford the most ready means of transporting the insect to other parts of the State. The territory that was found badly infested this spring, all lay in a strip along the street-car tracks between B and I streets; in no case as far as our observations went were the over-wintering individuals found farther than two blocks from the street-car tracks. The flies of the spring generation, however, spread the infestation two or three blocks, extending their range at certain points to the Southern

Pacific tracks. We did not discover any evidence of the insect on the other side of these railroad tracks. It would, however, be impossible to say that they had not passed beyond. We have but little doubt that the more outlying districts have always been free from the pest. A study of the map will show that these trees were defoliated as promptly, and nearly as completely, as the center of the town. The method of defoliation ordered by the State Commissioner of Horticulture was that illustrated in fig. 11. The majority of the citrus trees in town are high pruned, so that the work must be done from a step-ladder. Fig. 1, from a photograph taken by Professor Clarke

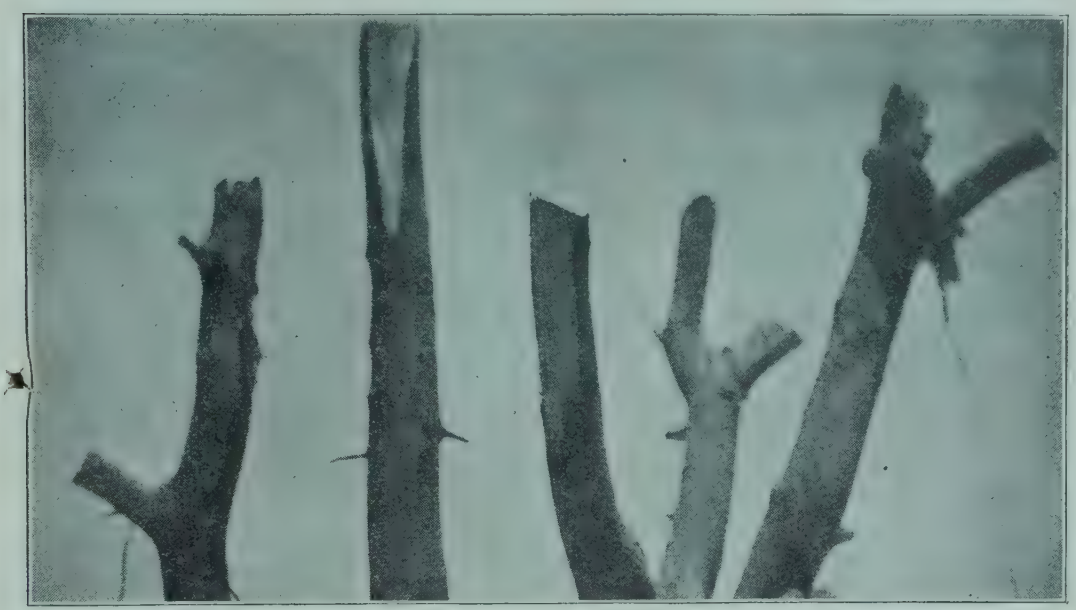


Fig. 2. The top of a defoliated tree, showing careless work.

on July 12, is a very good illustration of the method of handling the trees.*

Some of the work was well and carefully done, but there are many examples of very bad practice. A typical case of bad work is shown in fig. 2. There was very little skilled labor to be had, and the owners themselves, in most cases, knew but little about the handling of trees. A man with a saw and a white-wash brush, if he made a pretense of knowing about trees, could command from seven to ten dollars a day.

After cutting the trees, the brush was usually thrown into the street, and the city undertook to have the rubbish removed. This removal of the brush is the only assistance the citizens have received in the work, and no attempt has been made to secure uniformity, either

* I am indebted to Professor Clarke for most of the photographs in this circular.

Fig. 3. A brush pile in the street.

Fig. 4. Another larger brush pile.

in the time of cutting or in the disposal of the infested leaves. In some cases they were left on the ground beneath the trees, and in other cases the city allowed the brush heaps to remain in the streets or alleys till the flies emerged and until the adjacent trees were out in foliage again.

Fig. 3 is a fair example of this practice. On the left, the trees belonging to one lot have been cut for some time, the trunks whitewashed and the brush which was thrown into the street removed. On the right, the trees were just being defoliated on July 20, the date the photograph was taken.

Fig. 5. Loading brush for removal to the dumps.

The quantity of the brush that had to be disposed of was very large, for most of the trees were quite old, some upward of thirty years, and they had been allowed to grow as large as they would. The brush piles, therefore, on the sides of the streets were often very large. One of the larger piles is illustrated in fig. 4. In this case, however, the pile is composed in part of osage orange, which also was cut in some cases, though most of the osage orange in town is still standing.

The brush was gathered on wagons, as shown in fig. 5, and taken to a dumping ground, there unloaded, and allowed to dry ready for burning. No precaution was taken to prevent the scattering of infested leaves along the streets, and indeed dried orange leaves may be

found almost anywhere, though not numerously enough to be very conspicuous.

There were three dumping places used for the disposal of the brush. One of these was on the swampy land near the Southern Pacific tracks, within a hundred yards of orange trees. This dumping ground was only used a short time, however, though the brush is not yet burned. The greater part of this material was taken over the dyke and unloaded at G and Second streets. We show, at fig. 6, a bird's-eye-view of this dumping ground, taken from the top of a willow tree along the dyke near G street, looking across the sand-flats where

Fig. 6. A dump heap on the river.

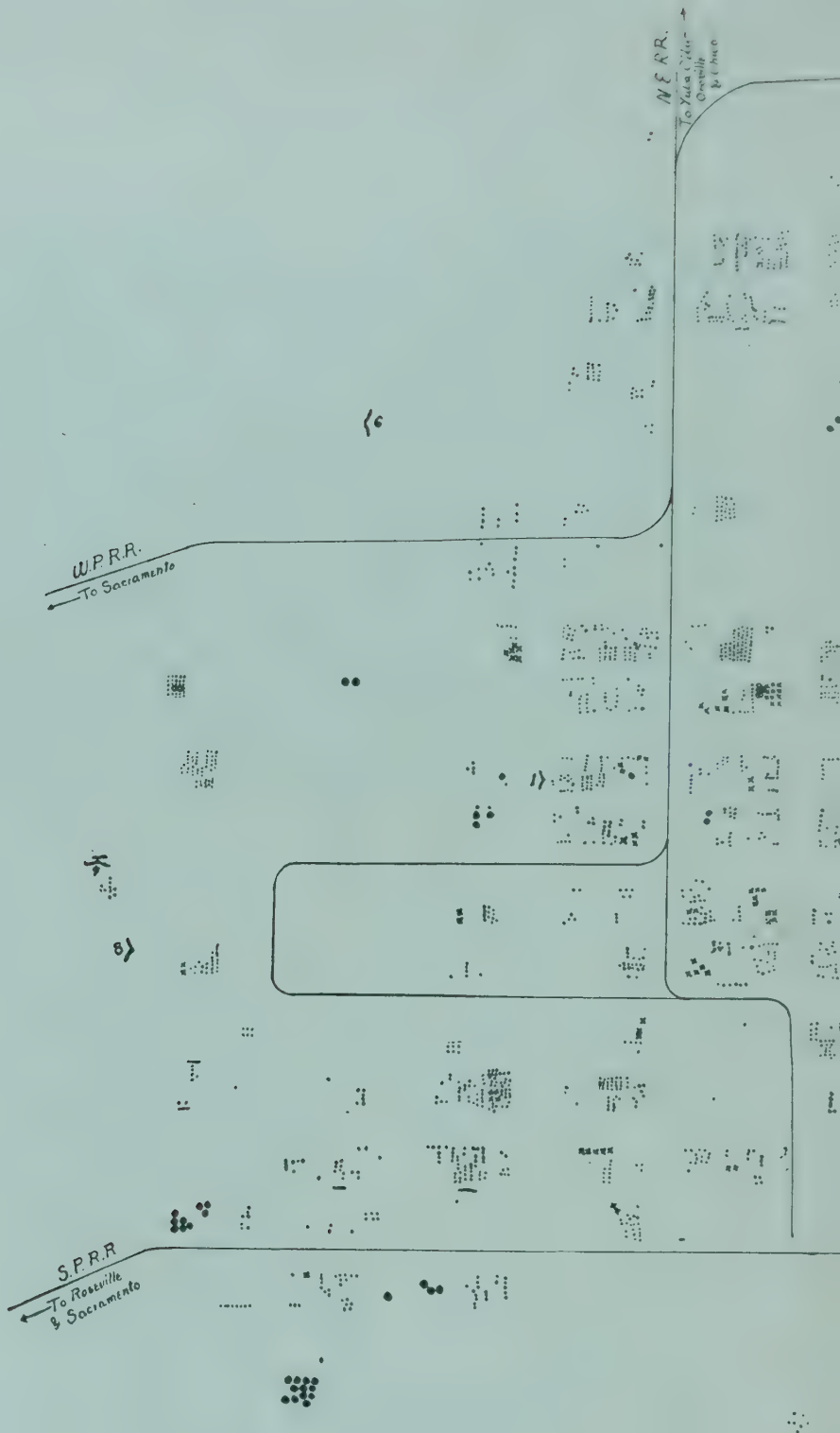
the dumps are and the river toward the Yuba City side. To the left will be seen the ashes of the trees brought to the dumps up to about July 12, the rest of the brush has accumulated since that date. The brush heaps occupy perhaps four or five acres.

A rough estimate made by Professor Clarke and myself of the contents of this dump pile is as follows: Brush from citrus trees, 85 per cent.; osage orange, 10 per cent.; persimmon, 3 per cent.; privet, 2 per cent.; with very small amounts of jasmine, honeysuckle, bridal-wreath, rose, fig, and palm.

The fact that the white fly was already on the wing in great numbers as early as the 12th of July, and that practically all of the brush shown in fig. 6 was taken there after that date, shows that the insect was given ample time to develop before defoliation. The presence of new foliage on trees all over town shows further that the insects had

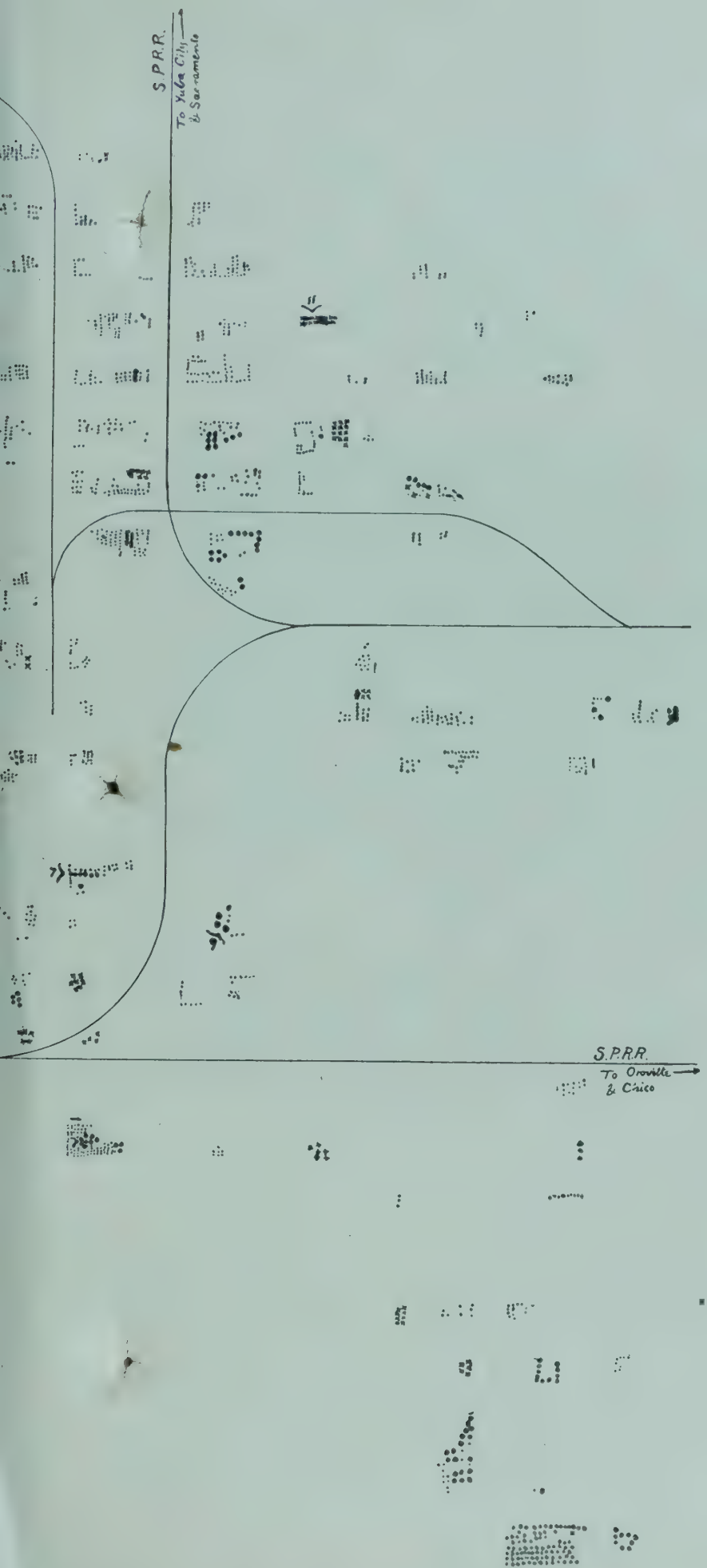
Fig. 7. Orange trees in foliage and defoliated.

Fig. 8. Small potted orange trees that escaped the inspector.



Map of Marysville
Railroad Lines
and condition of
Orange & Lemon Trees
July 20 1907

s undefoliated trees
o partly defoliated
· defoliated
x with new foliage
— brush piles on the street
) figure in this circular


S.P.R.R.
To Yuba City
& Sacramento
S.P.R.R.
To Oroville
& Chico

no lack of young foliage on which to deposit their eggs. Fig. 7, from a photograph taken as late as July 20, illustrates how trees were allowed to remain in foliage long after the neighboring trees were defoliated, so that, as the new leaves came out, the white flies were right at hand. The inspection of the map will show numerous cases where even in the same lot one or more trees were untouched while the rest were defoliated. It does not show many other cases where these favored trees were finally cut down, but not till after they fur-

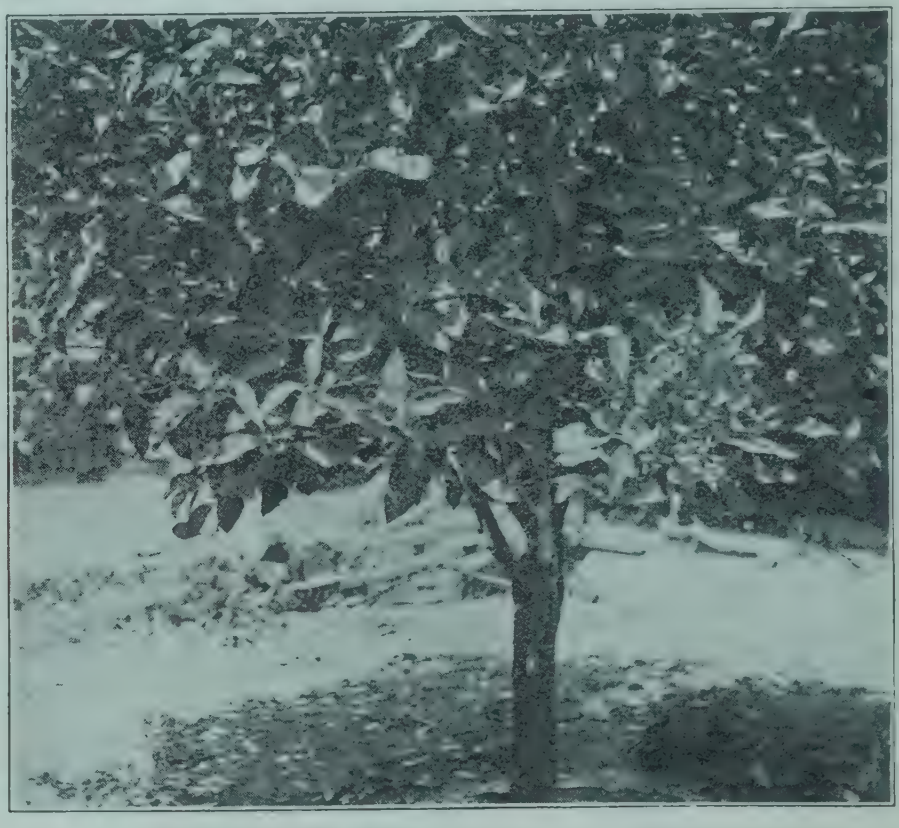


Fig. 9. One of numerous undefoliated trees.

nished winged insects to infest neighboring trees just coming out again into foliage.

In the map and in most of the discussion above, the citrus trees alone have been considered. These alone have been cut out with any attempt at thoroughness. Some of the other food plants have been quite as heavily infested as any of the orange trees.

The original order of the State Commissioner did not include all. The newspaper articles urging active work have usually been quiet in reference to other food plants, and the people generally seem to have lost sight of the fact that the defoliation of such plants is quite as

important as the orange trees. The fig is extremely abundant in Marysville, and is known to furnish food for the young insect, but practically nothing has been done towards defoliating these trees. This is a case of an occasional food plant, for we have not seen a single infested fig-leaf in Marysville. The insect evidently prefers the orange, but it is certainly not wise, when complete eradication is attempted, to utterly neglect a possible source of reinfestation of the orange trees. Figs and oranges are in immediate contact all over town, an example of which is shown in fig. 10.

Fig. 10. Adjacent Fig and Orange trees, the latter defoliated.

New foliage on the trimmed orange trees was reported in the Marysville papers by the 10th of July, and was to be seen even earlier than that. It is now to be found in all parts of the town, as shown on the map, where only the more conspicuous examples were noted. In many cases the new shoots are over a foot long, and some quite two feet long. In such cases the young leaves have been subject to reinfestation for a full two weeks at the date of this writing. Those in charge of the work are still trying to force further defoliation. Under the circumstances it is hard to see how any good purpose could be

served by further action at this time. The opportunity for effective work along these lines is past; now we are face to face with new conditions.

What to Do Next.

Some are ready to advocate that we do nothing. They are ready to trust to the chance that it may not spread from Marysville into the orchard districts, or if it gets there, that it may find the conditions unfavorable to it, or that some parasitic insects may be discovered that

Fig. 11. Defoliated tree coming into foliage.

will render it innocuous, or some other contingency making its destruction unnecessary.

Granting that any or all of these contingencies may occur, it is nevertheless the part of wisdom to make a determined fight as long as there is a reasonable chance that it may be exterminated.

The failure of the past campaign need not dishearten us in any particular, for, as the account of the work given above clearly indicates, the management of the past campaign has been fundamentally bad, and its history chiefly useful in pointing out how not to do the work.

There are only two periods of the year when the eradication of the white fly can be undertaken with any reasonable hope of success. They are the two periods when all the individuals are attached to the leaves and possess neither wings nor legs. The longest and best period for the work is during the winter. While the insects may be able to feed and grow during this period, coming gradually to full size, they are finally brought to a standstill, being unable to transform into the winged condition until the weather is warmer. Thus it comes about that the insects that were of all sizes in the fall, reach the winged condition in the spring at the same time. Both preceding and following this great spring brood of flies there is a period when all are wingless. All through the month of May and well into June the insects of this spring brood were on the wing and laying eggs. Some of the young hatching from these eggs were fully a month older than the youngest members of the family. Thus there is only a brief period during which successful work could be done. The quiescent period of winter is much longer.

From early in July, through the remainder of the summer and probably until killing frosts come, the insect is continually on the wing, owing to the overlapping of broods, rendering eradication at this time hopeless.

Summer Work.

While the insect cannot be eradicated at this time of the year, there is much important work to do, upon the doing of which the success of next winter's campaign will depend.

The man put in charge of the work should begin at once, and have a sufficient number of assistants to do it thoroughly. These assistants should be selected for three different classes of work, and each group put in immediate charge of an expert in that particular line. These three lines of work should be as follows:

First—A horticultural staff should be selected, whose first work should be to assist the people of Marysville in making trees again out of the stumps now standing. They are in need of expert assistance. This staff must prove to the citizens of that town that they are endeavoring to be genuinely helpful, that this campaign will be managed with their interests uppermost. They will also make themselves familiar with every detail of the situation and be ready to take immediate charge of the defoliation of next winter.

Second—There should be a staff of inspectors, working both in Marysville and the surrounding country, continually on the search for infested trees. The work of this staff will have to be continued for at least a year after the last white fly is seen.

Third—A staff of investigators should make an exhaustive study of the habits of the fly, particularly testing out experimentally the possible range of the food habits of the insect. We ought to be in a position to say, with full confidence, just what plants to take into consideration in the winter work; furthermore, we must know, beyond question, whether the insect can live on fallen leaves, as so many species of white flies do, so that we shall know what to do with deciduous trees. Finally, this staff shall be the place of appeal for the other departments of the work.

The summer work, as outlined, is necessary to make a sound foundation for the winter's campaign.

Winter Work.

The character of the winter work has been foreshadowed in describing that of the summer. The exact course to follow will depend, in a large measure, on the results of the summer's investigation. Certain general plans can, however, be now given.

The horticultural staff would have to be greatly enlarged and separated into two divisions. To one would be given the defoliation work; to the other, the cleaning up and disposal of infested material. The latter division would act as a check upon the former division, and the staff of inspectors following them would insure that all is thoroughly done.

This plan of campaign involves that the actual work of defoliation be done by those in charge of the work, and is the only practical method of securing uniformity and thoroughness. The cost of the work should not be assessed against the owners of the properties involved. The work of defoliation should be completed as soon as pos-

sible after all eggs are laid in the fall and the winged forms have disappeared.

A programme of work, like that outlined above, does offer some hope of the eradication of the pest; but unless ample provision is made for it and scientific accuracy and thoroughness insured by the appointment of the right kind of men to organize and direct the same, satisfactory results will not be secured.

19·3·08

UNIVERSITY OF CALIFORNIA PUBLICATIONS.

COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

18·3·08

COMMERCIAL FERTILIZERS.

By JOHN S. BURD.

BULLETIN No. 189.

(Berkeley, Cal., June 30, 1907.)

SACRAMENTO:

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1907.

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COMMERCIAL FERTILIZERS.

By JOHN S. BURD.

The present year is the fourth of the existence of the State Fertilizer Control and of the issuance by this Station of publications dealing exclusively with commercial fertilizers. This bulletin gives the results of the inspections and analyses of the various brands found on the market during the half-year ending June 30, 1907. The tables are commended to the attention of all those proposing to purchase fertilizers, as indicating the character of the goods and the reliability of the guaranties of the various manufacturers.

It is perhaps not too much to claim that these systematic inspections have resulted in materially raising the standard of the fertilizers sold in this State. That such is the case we have been repeatedly assured by those who have had occasion to purchase fertilizers before and from time to time since the passage of the Fertilizer Control law. Confirmation of this is offered in the statistical data we are now able to give. These data comprise the deficiencies (greater than those allowed by law) reported during the past three years. The figures for the first year of the inspection 1903-04 being eliminated, because of the small number of samples examined, the necessarily desultory character of the inspection, and the fact that a number of confessedly deficient samples collected were not analyzed, owing to the promise of the manufacturers of withdrawing the goods represented from the market.

DEFICIENCIES FOUND 1904-1907.

	1904-05.	1905-06.	1906-07.
Total number of deficiencies of ingredients..	82	117	95
Total number of deficiencies possible. (Number of ingredients)	600	913	894
Percentage of ingredients deficient	13.7	12.8	10.6
Number of samples deficient in valuation	12	19	15
Number of guaranteed samples examined	229	377	*362
Percentage of samples deficient in valuation	5.24	5.04	4.14

A constant and satisfactory decrease in the percentage of ingredients deficient and also in the percentage of samples deficient in valuation is here indicated.

*During this year 47 additional samples were examined which were either sold on a basis of Station analysis or did not come within the legal definition of a commercial fertilizer. No guaranty was required on this class of materials, so that they are not represented in this table.

SCOPE OF INSPECTION.

From January 1 to June 30, 1907, 226 samples of fertilizers and fertilizing materials have been received at the laboratory. Of this number, 15 were sent by farmers under the two-dollar fee provision, 52 were taken by inspectors from purchasers' goods upon the request of the purchasers, and 159 were taken by inspectors from goods in the hands of agents and manufacturers. On 6 samples the analysis as reported was used as a basis of settlement by mutual agreement of buyer and seller. No guaranty was required or given with goods sold under such an agreement.

FERTILIZER VALUATIONS.

The calculations of the commercial values of the fertilizers here reported are made on the so-called unit basis. Such calculations consist simply in multiplying the number of per cent of each ingredient by the price per unit and adding the products. The sum thus obtained is the commercial value per ton at the prices used. If it is desired to use such a calculation for determining the amount which should be paid for goods, or the rebate to which the buyer is entitled owing to the goods delivered being below the guaranty, it can only be satisfactorily done if a definite price per unit has been agreed upon between buyer and seller. But for the mere purpose of showing the relative values of goods to guaranties, it is not at all necessary that the prices adopted should be the exact market prices. Thus it is that the Fertilizer Control in attempting to show the relation between values found and values claimed, uses a schedule which is admittedly only an approximate average of market values. Owing to market fluctuations, differences in cost of delivery at different points, and other causes, the obtaining of true average market prices is an impossibility. But if the reader will bear in mind the true purpose of the valuations reported, these will have served their turn and he will not be led to assume that the Experiment Station is dictating the prices at which goods shall be sold.

SCHEDULE OF TRADE VALUES.*

Phosphoric Acid.	Cents Per Pound.	Value Per Unit.
Available (water and citrate-soluble)	6	$1 20
Insoluble in mixed fertilizers	2½	0 50
In fine† bone and tankage	4½‡	0 90
In medium† bone and tankage	3½‡	0 70
In fine† Thomas phosphate powder	5†	1 00
In medium† Thomas phosphate powder	3†	0 60
Nitrogen.		
In ammonia salts	18	3 60
In nitrates	16½	3 30
Organic in—		
Blood	18½	3 70
Mixed fertilizers	18	3 60
Fine† bone and tankage	18†	3 60
Medium† bone and tankage	14†	2 80
Potash.		
From sulfate	6	1 20
From muriate	5	1 00

The following classification may be made of samples reported in this bulletin:

Complete fertilizers	120
Bone meal	39
Tankage	21
Nitrogenous superphosphate	1
Superphosphate and potash	2
Superphosphate	6
Dried blood	11
Nitrate of soda	9
Sulfate of potash	3
Bat guano	3
Total	215

*Owing to a considerable increase in the market price of nitrogen containing materials, the valuation of this ingredient will be increased in succeeding reports.

†Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas phosphate powder by a 100-mesh sieve.

‡For the purpose of calculating comparative values an average value of 4 cents per pound for phosphoric acid and 17 cents for nitrogen is used on bone meal and tankage; an average of 4½ cents per pound is used for phosphoric acid in Thomas phosphate powder.

DEFICIENCIES.

In the analyses of the above samples, the following number of deficiencies greater than allowed by law occur:

Available phosphoric acid (total when available is not guaranteed)	22
Total nitrogen	30
Potash	11
In valuation	9

These deficiencies were found in 58 samples.

The fertilizer law allows a deficiency of 0.25 per cent in nitrogen, 0.50 per cent in potash, and 1.00 per cent in available phosphoric acid.

REPORT OF ANALYSES.*

Available phosphoric acid is not determined in bone meal, tankage, and Thomas phosphate powder, unless requested. The fineness of these materials is determined, fine and medium bone being separated by a sieve of 50 meshes to the inch; tankage by a 25-mesh sieve; and Thomas phosphate powder by a 100-mesh sieve.

Some fertilizers containing all three ingredients are rated as tankage, because they are non-acidulated tankage products with potash salts added, and do not carry a guaranty of available phosphoric acid.

Nitrogen in ammonia salts will, in some cases, be found reported when nitrogen in this form is not guaranteed. In some of such cases this form of nitrogen is produced by conversion of organic nitrogen during process of manufacture, and is not to be considered a deviation from guaranty of materials used. Guanos carry more or less nitrogen in nitrates and ammonia salts, and when any appreciable quantity of guano is used the manufacturer should take into account the fact that some nitrogen will show as nitrates and ammonia salts. The failure to take this into consideration may perhaps account for the appearance of these forms of nitrogen in some samples in which only organic nitrogen was guaranteed.

The percentage of chlorin is given when it exceeds 0.50 per cent. It is a matter of only technical interest whether chlorin present is from muriate of potash, kainit, or from common salt that may be in some of the materials used. If a manufacturer uses sulfate of potash and uses

*The laboratory work in connection with these analyses was largely carried out by Mr. Ludwig Rosenstein, to whom credit is due for his careful and conscientious work.

a tankage with it containing a large amount of chlorin, from a practical standpoint he has lowered the grade of his fertilizer just as much as if he had used muriate of potash instead of sulfate of potash. Chlorin from all other sources is as objectionable as from muriate of potash. However, if muriate of potash is found when sulfate is guaranteed, the fact will be published.

The following abbreviations are used in the tables: Bl=blood; Bn=bone; Fs=fish; G=guano; Super=superphosphate; T=tankage.

Guaranties are entered in *italics*. Deficiencies greater than allowed by law are entered in bold type.

ANALYSES AND VALUATIONS.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Agricultural Chemical Works, Los Angeles, Cal.		
1060	Bat Guano	Thos. Moffatt, Rialto	22.11
	Guaranteed		*21.20*
1136	Bat Guano and Bone	J. C. Wright, Azusa	43.06
	Guaranteed		*44.50*
1102	Ba Guano and Gypsum	W. H. Collins, Covina	41.41
1129	do	A. Bowring, Charter Oak	46.27
1133	do	J. Quick, Azusa	44.12
	Guaranteed		*41.80*
1072	Berry	E. A. Moore, Redlands	24.84
	Guaranteed		*24.40*
992	Blood	E. A. Moore, Redlands	**46.92**
	Guaranteed		*48.10*
1103	Blood	E. T. Watson, Redlands	50.06
	Guaranteed		*49.95*
994*	Bone	E. A. Moore, Redlands	31.77
	Guaranteed		*26.20*
1073	Bone Flour	E. A. Moore, Redlands	29.15
	Guaranteed		*24.94*
1158	Bone Flour	W. J. Rogers, Pomona	32.45
	Guaranteed		*25.68*
1159*	Fine Ground Bone	W. J. Rogers, Pomona	30.61
	Guaranteed		*26.90*
1168	Fine Ground Bone	G. A. Herdeg, Riverside	33.47
	Guaranteed		*29.34*
1146*	Steamed Bone Meal	Sweetwater Fruit Co., Bonita	31.74
	Guaranteed		*30.34*
1104	Nitrate of Soda	E. T. Watson, Redlands	51.08
1119	do	C. A. Whitaker, Covina	**50.29**
1160	do	W. J. Rogers, Pomona	51.02
1161	do	do	51.48
	Guaranteed		*51.15*
1120	Special	C. A. Whitaker, Covina	36.55
	Guaranteed		*30.45*
1029	Special	Upland Feed and Fuel Co., Upland	24.19
1162	do	W. J. Rogers, Pomona	23.52
	Guaranteed		*22.40*
1037	Special Orange and Lemon	A. L. Wright, Rialto	27.53
	Guaranteed		*27.32*
1049	Special Orange and Lemon	G. A. Herdeg, Riverside	24.44
	Guaranteed		*25.20*
1061	Special Orange and Lemon	Thos. Moffatt, Rialto	42.79
	Guaranteed		*38.30*
1169	Special Orange and Lemon	G. A. Herdeg, Riverside	24.64
	Guaranteed		*25.50*
996	Special Orange and Lemon	E. A. Moore, Redlands	28.12
1181	do	Gowan & Willard, Santa Ana	26.27
	Guaranteed		*25.70*
1000	Special Orange and Lemon	E. A. Moore, Redlands	23.72
1182	do	Gowan & Willard, Santa Ana	22.59
	Guaranteed		*22.40*
997*	Summer "A"	E. A. Moore, Redlands	28.30
	Guaranteed		*25.90*

*994—31 per cent fine.
*1159—40 per cent fine. Contains hoof.
*1146—59 per cent fine.
* 997—Some hoof.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds Per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
1060			**8.85**				3.99		3.99			0.56	
			10.00				*3.50*		*3.50*			*0.50*	
1136			10.28				9.94		**9.94**			0.87	
			9.50				*10.50*		*10.50*			*1.00*	
1102			4.30				10.08		10.08			1.41	
1129			5.05				11.15		11.15			1.74	
1133			5.65				10.48		10.48			1.56	
			5.00				*10.00*		*10.00*			*1.50*	
1072	5.42	3.50	8.92				3.16		3.16		**4.34**		0.62
	6.00	*2.00*	*8.00*	Super T			*2.50*	Bl, Bn	*2.50*		*6.00*		
992							12.68		**12.68**				
							13.00		*13.00*				
1103							13.53		13.53				
							13.50		*13.50*				
994			23.32				3.88		3.88				
			20.00				*3.00*		*3.00*				
1073	15.02	14.66	29.68				1.12		1.12				
	16.00	*4.00*	*20.00*				*1.10*		*1.10*				
1158	18.90	11.32	30.22				1.21		1.21				
	16.20	*4.60*	*20.80*				*1.16*		*1.16*				
1159			**21.44**				3.96		3.96				
			23.00				*2.50*		*2.50*				
1168	15.72	13.58	29.30				2.30		2.30				
	11.00	*18.00*	*29.00*				*2.10*		*2.10*				
1146			29.14				2.48		2.48				
			29.00				*2.10*		*2.10*				
1104					15.48				15.48				0.76
1119					15.24				**15.24**				
1160					15.46				15.46				
1161					15.60				15.60				
					15.50				*15.50*				
1120	12.22	0.28	12.50		2.77		1.63		4.40		5.62		0.50
	10.00			Super	*2.50*		*1.50*	Bl	*4.00*		*4.00*		
1029	5.57	8.45	14.02				3.05		3.05		1.91		0.56
1162	5.80	4.41	10.21				2.94		2.94		3.14		
	6.00	*4.00*	*10.00*	Super T			*3.00*	Bl, Bn	*3.00*		*2.00*		
1037	**5.02**	5.51	10.53				3.44		3.44		5.87		
	9.00	*1.00*	*10.00*	Super T			*3.30*	Bl, Bn	*3.30*		*4.00*		
1049	**4.40**	4.53	8.93		1.34		2.68		4.02		2.35		
	6.00	*3.00*	*9.00*	Super T	*1.00*		*3.00*	Bl, Bn	*4.00*		*2.00*		
1061	10.07	4.38	14.45				7.76		7.76		**0.48**		0.70
	7.00	*7.00*	*14.00*	Super T			*7.00*	Bat G	*7.00*		*1.00*		
1169	**3.28**	7.04	10.32		0.54	0.41	3.23		4.18		1.92		0.58
	5.00	*6.00*	*11.00*	Super T	*1.00*		*3.00*	Bl, Bn	*4.00*		*2.00*		
996	6.58	6.00	12.58		1.09		3.03		4.12		2.26		
1181	5.32	4.21	9.53		0.91		3.28		4.19		2.47		
	6.00	*4.00*	*10.00*	Super T	*1.00*		*3.00*	Bl, Bn	*4.00*		*2.00*		
1000	5.46	6.16	11.62				3.25		3.25		1.99		0 58
1182	5.62	4.54	10.16				3.03		3.03		2.22		
	6.00	*4.00*	*10.00*	Super T			*3.00*	Bl, Bn	*3.00*		*2.00*		
997	5.68	5.89	11.57				1.86		1.86			9.86	
	5.00	*5.00*	*10.00*	Super T			*1.50*	Bl, Bn	*1.50*			*10.00*	

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Agricultural Chemical Works, Los Angeles, Cal.—Continued.		
998	Summer, "A"	E. A. Moore, Redlands	27.29
	Guaranteed		*25.20*
999	Summer, "B"	E. A. Moore, Redlands	26.21
	Guaranteed		*22.10*
1112	Superphosphate	W. H. Collins, Covina	24.73
	Guaranteed		*24.00*
1001*	Tankage	E. A. Moore, Redlands	34.81
1002*	do	F. H. Clock, Redlands	31.83
1009*	do	E. A. Moore, Redlands	35.51
1074*	do	H. H. Pettitt, Redlands	33.47
	Guaranteed		*33.35*
1075*	Tankage	E. A. Moore, Redlands	24.58
1170*	do	G. A. Herdeg, Riverside	26.03
	Guaranteed		*25.65*
993*	Tankage	E. A. Moore, Redlands	27.82
	Guaranteed		*26.50*
1183	Walnut	Gowan & Willard, Santa Ana	25.15
	Guaranteed		*24.00*
	American Agricultural Chemical Co., Los Angeles, Cal.		
1140	Fruit and Vine	W. R. Powell, Glendora	27.55
	Guaranteed		*24.86*
1200	Bradley's Lawn	Pacific Wood and Coal Co., San Diego	28.42
1201	Bradley's Lemon Tree	do	27.92
988	Nursery Stock	James M. Riley, Los Angeles	26.97
1038	Bradley's Nursery Stock	J. F. Monro, Upland	29.60
1048	do	L. V. W. Brown, Riverside	28.51
1059	do	Mrs. M. E. Wallace, Rialto	28.51
1084	do	E. Highland Orange Co., E. Highland	27.87
1164	do	S. J. Carroll, Whittier	30.69
1171	do	T. P. Drinkwater, Corona	28.56
1185	do	W. L. Hale, Fullerton	27.74
	Guaranteed		*27.17*
1202	Bradley's Nursery Stock	F. E. Dudderar, Covina	27.01
1184	do	R. H. Hille, Fernando	26.60
	Guaranteed		*27.62*
1030	Bradley's Orange and Lemon	J. F. Monro, Upland	27.16
1203	do	F. E. Dudderar, Covina	27.97
1204	do	Pacific Wood and Coal Co., San Diego	27.36
	Guaranteed		*26.42*
	Armour Fertilizer Works, Los Angeles, Cal.		
1013	Blood	I. W. Freeman, Redlands	**41.88**
1196	do	J. C. Boyd, Rialto	**46.47**
	Guaranteed		*48.10*
1095	Blood	A. M. Seeley, Covina	53.20
	Guaranteed		*51.80*
1121	Blood	John P. Linfesty, Highland	**44.10**
1149	do	W. B. Hinckley, Redlands	45.88
	Guaranteed		*46.25*
1062	Bone, Blood, and Potash	B. E. Sibley, Rialto	33.29
1096	do	C. G. Twist, Azusa	33.50
1113	do	A. M. Seeley, Covina	35.94
1122	do	John P. Linfestey, Highland	35.60
	Guaranteed		*33.40*

*1001—78 per cent fine. *1075—73 per cent fine. *1002—85 per cent fine.
*1170—73 per cent fine. *1009—82 per cent fine. * 993—73 per cent fine.
*1074—69 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID.				NITROGEN.					POTASH.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
998	3.20	6.94	10.14				1.92		1.92		10.89		0.78
	4.00	*6.00*	*10.00*	Super T			*1.50*	Bl, Bn	*1.50*		*10.00*		
999	9.29	4.94	14.23				1.81		1.81		5.06		0.66
	6.00	*7.00*	*13.00*	Super T			*1.50*	Bl, Bn	*1.50*		*5.00*		
1112	20.61	0.37	20.98										
	20.00												
1001			13.51				7.06		7.06				
1002			14.73				6.25		**6.25**				
1009			**9.02**				8.32		8.32				
1074			14.43				6.45		**6.45**				
			13.00				*6.75*		*6.75*				
1075			13.14				4.14		4.14				
1170			14.99				4.13		4.13				
			14.00				*4.25*		*4.25*				
993			18.32				3.87		**3.87**				
			14.00				*4.50*		*4.50*				
1183	6.12	4.11	10.23		0.54		2.61		3.15		3.80		
	6.00	*3.00*	*9.00*	Super T	*1.00*		*2.00*	Bl, Bn	*3.00*		*4.00*		
1140	8.84	1.21	10.05	All samples of complete fertilizer of this company, Bn, Super.	2.04	0.36	0.86	All samples of complete fertilizer of this company, Bl, Bn, Bat G, Fs, G, T.	3.26		**4.34**		
	7.00	*1.00*	*8.00*		*1.60*	*0.30*	*1.00*		*2.90*		*5.00*		
1200	9.19	1.21	10.40		2.88	0.44	0.85		4.17		2.20		
1201	8.56	1.52	10.08		3.26	0.42	0.60		4.28		2.05		
988	8.93	1.01	9.94		2.47	0.50	1.07		4.04		1.62		
1038	9.39	0.98	10.37		3.02	0.47	1.01		4.50		2.12		
1048	8.86	1.00	9.86		2.83	0.39	1.15		4.37		2.07		
1059	8.37	1.53	9.90		3.20	0.27	0.98		4.45		2.20		
1084	9.12	0.96	10.08		2.73	0.49	1.01		4.23		1.70		
1164	10.85	1.67	12.52		2.93	0.45	0.82		4.20		2.16		0.52
1171	9.33	1.43	10.76		2.93	0.57	0.76		4.26		1.82		0.62
1185	9.48	1.02	10.50		2.47	0.27	1.26		4.00		1.83		
	9.00	*1.00*	*10.00*		*2.30*	*0.40*	*1.40*		*4.10*		*1.50*		
1202	8.46	1.54	10.00		1.86	0.60	1.54		4.00		1.87		
1184	**7.54**	2.50	10.04		1 94	0.67	1.43		4.04		1.95		0.70
	9.00	*1.00*	*10.00*		*0.80*	*0.35*	*2.95*		*4.10*		*1.50*		
1030	7.53	0.93	8.46		2.67	0.56	0.76		3.99		3.41		0.54
1203	8.61	1.21	9.82		2.85	0.46	0.58		3.89		3.24		
1204	7.98	1.29	9.27		2.73	0.40	0.70		3.83		3.47		
	8.00	*1.00*	*9.00*		*2.00*	*0.40*	*1.30*		*3.70*		*3.00*		
1013							11.32		**11.32**				
1196							12.56		**12.56**				
							13.00		*13.00*				
1095							14.38		14.38				
							14.00		*14.00*				
1121							11.92		**11.92**				
1143							12.40		12.40				
							12.50		*12.50*				
1062	8.45	2.17	10.62			1.53	2.50		4.03		**6.29**		
1096	8.84	1.75	10.59			1.63	2.26		3.89		6.68		0.70
1113	9.09	1.21	10.33		0.23	1.70	2.29		4.22		7.24		0.58
1122	8.93	1.52	10.45	Bn. G. Super	0.25	1.60	2.40		4.25		7.41		0.58
	8.00	*2.00*	*10.00*			*1.50*	*2.50*	Bl, Bn, G, T	*4.00*		*7.00*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Armour Fertilizer Works, Los Angeles, Cal.—Continued.		
1205	Bone, Blood, and Potash	H. P. Greene, San Diego	33.80
	Guaranteed		*32.80*
1071*	Bone Floats	James Waters, Colton	**25.92**
	Guaranteed		*29.40*
990*	Bone Meal	R. T. Murrell, Pomona	27.94
1003*	do	W. T. Henderson, Riverside	27.89
1012*	do	I. W. Freeman, Redlands	29.75
1025*	do	G. W. Russell, Ontario	30.75
1186*	do	Santiago O. G. Association, Orange	27.52
991*	do	F. P. Gaul, San Dimas	28.46
	Guaranteed		*28.65*
1180*	Bone Meal	W. T. Henderson, Riverside	29.08
	Guaranteed		*27.70*
1097	Fruit and Vine	A. M. Seeley, Covina	30.09
	Guaranteed		*27.40*
1064	Fruit and Vine	J. C. Boyd, Rialto	29.56
1150	do	I. W. Freeman, Redlands	29.83
1206	do	H. P. Greene, San Diego	28.71
	Guaranteed		*27.25*
1050	Lawn and Garden	Blake Bros., Pasadena	23.55
	Guaranteed		*24.35*
1207	Lawn and Garden	H. P. Greene, San Diego	23.58
	Guaranteed		*23.90*
1151	Nitrate of Soda	I. W. Freeman, Redlands	52.14
1165	do	R. T. Murrell, Pomona	51.02
	Guaranteed		*49.50*
995	Orange Tree Manure	W. T. Henderson, Riverside	28.01
1014	do	do	27.49
1015	do	G. W. Russell, Ontario	30.26
1110	do	National Orange Co., Riverside	28.29
	Guaranteed		*26.05*
1128	Orange Tree Manure	E. B. Clark, Pomona	26.80
1031	do	H. A. Brimmer, San Bernardino	38.05
1065	do	J. C. Boyd, Rialto	27.80
1098	do	A. M. Seeley, Covina	27.80
	Guaranteed		*26.20*
1024	Pea Special	I. W. Freeman, Redlands	31.04
1152	do	do	26.19
	Guaranteed		*21.30*
1026	Pea Special	G. W. Russell, Ontario	25.02
	Guaranteed		*25.10*
1099	Special	A. M. Seeley, Covina	37.96
	Guaranteed		*40.00*
1100	Special	A. M. Seeley, Covina	32.78
	Guaranteed		*32.20*
1116	Armour's Special Fertilizer	W. H. Overholtzer, Covina	30.24
	Guaranteed		*27.85*
1017	Special 5-8-2	I. W. Freeman, Redlands	28.21
	Guaranteed		*27.25*
1063	Special 5-8-2	J. C. Boyd, Rialto	28.24
1101	do	A. M. Seeley, Covina	30.04
1187	do	Santiago O. G. Association, Orange	28.78
	Guaranteed		*27.40*
1166	Special 5-8-2	R. T. Murrell, Pomona	31.25
1208	do	H. P. Greene, San Diego	29.27
	Guaranteed		*26.80*

*1071—99 per cent fine. *1003—67 per cent fine. * 990—69 per cent fine.
*1012—66 per cent fine. *1025—75 per cent fine. *1186—62 per cent fine.
* 991—67 per cent fine. *1180—65 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds Per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
1205	8.14	1.52	9.66	Bn, G, Super	1.88	------	2.24	----------	4.12	------	7.51	------	----
----	*8.00*	*2.00*	*10.00*		*2.00*	------	*2.00*	Bl, Bn, G, T	*4.00*	------	*7.00*	------	----
1071	------	------	23.18	------	------	------	2.17	----------	**2.17**	------	------	------	----
----	------	------	*24.00*	------	------	------	*3.00*	----------	*3.00*	------	------	------	----
990	------	------	21.92	------	------	------	3.06	----------	3.06	------	------	------	----
1003	------	------	23.17	------	------	------	2.75	----------	**2.75**	------	------	------	----
1012	------	------	22.74	------	------	------	3.40	----------	3.40	------	------	------	----
1025	------	------	29.30	------	------	------	2.15	----------	**2.15**	------	------	------	----
1186	------	------	22.92	------	------	------	2.70	----------	**2.70**	------	------	------	----
991	------	------	21.72	------	------	------	3.26	----------	3.26	------	------	------	----
----	------	------	*22.00*	------	------	------	*3.25*	----------	*3.25*	------	------	------	----
1180	------	------	26.24	------	------	------	2.38	----------	2.38	------	------	------	----
----	------	------	*24.00*	------	------	------	*2.50*	----------	*2.50*	------	------	------	----
1097	6.85	1.28	8.13	Bn, G, Super	------	1.07	0.96	----------	2.03	------	11.60	------	0 90
----	*6.00*	*2.00*	*8.00*		------	*1.00*	*1.00*	Bl, Bn, G, T	*2.00*	------	*10.00*	------	----
1064	6.78	3.08	9.86	------	0.85	------	1.32	----------	2.17	------	10.28	------	0.60
1150	6.08	0.89	6.97	------	1.01	------	1.24	----------	2.25	------	11.91	------	----
1206	6.99	0.89	7.88	Bn, G, Super	1.24	------	1.05	----------	2.29	------	10.06	------	----
----	*6.00*	*2.00*	*8.00*		*0.50*	------	*1.50*	Bl, Bn, T	*2.00*	------	*10.00*	------	----
1050	4.66	0.74	5.40	Bn, G, Super	0.36	------	3.28	----------	**3.64**	------	3.82	------	----
----	*4.00*	*1.00*	*5.00*		*0.50*	------	*3.50*	Bl, Bn, G, T	*4.00*	------	*4.00*	------	----
1207	3.15	0.84	3.99	Bn, Super	1.66	------	2.30	----------	3.96	------	4.68	------	0.70
----	*4.00*	*1.00*	*5.00*		*2.00*	------	*2.00*	Bl, Bn, T	*4.00*	------	*4.00*	------	----
1151	------	------	------	------	15.80	------	------	----------	15.80	------	------	------	----
1165	------	------	------	------	15.46	------	------	----------	15.46	------	------	------	----
----	------	------	------	------	*15.00*	------	------	----------	*15.00*	------	------	------	----
995	8.09	0.98	9.07	------	0.56	------	2.98	----------	3.54	------	4.36	------	----
1014	9.92	2.37	11.59	------	0.70	------	2.22	----------	2.92	------	4.11	------	0.74
1015	10.79	1.68	12.47	------	0.74	------	2.75	----------	3.49	------	**3.44**	------	0.58
1110	9.24	1.04	10.28	Bn, G, Super	0.55	------	2.58	----------	3.13	------	4.66	------	----
----	*8.00*	*2.00*	*10.00*		*0.50*	------	*2.50*	Bl, Bn, G, T	*3.00*	------	*4.00*	------	----
1128	7.84	2.46	10.30	------	------	1.49	1.62	----------	3.11	------	4.14	------	0 50
1031	8.64	1.71	10.35	------	0.11	1.85	1.44	----------	3.40	------	3.85	------	----
1065	9.11	1.74	10.85	------	------	1.49	1.66	----------	3.15	------	3.88	------	0.52
1098	8.93	1.52	10.45	Bn, G, Super	0.23	1.44	1.50	----------	3.17	------	4.15	------	0.52
----	*8.00*	*2.00*	*10.00*		------	*1.50*	*1.50*	Bl, Bn, G, T	*3.00*	------	*4.00*	------	----
1024	12.34	8.41	20.75	------	------	------	1.99	----------	1.99	------	4.05	------	----
1152	10.59	2.23	12.82	Bn, Super	------	------	1.83	----------	1.83	------	4.81	------	----
----	*6.00*	*6.00*	*12.00*		------	------	*1.75*	Bl, Bn, T	*1.75*	------	*4.00*	------	----
1026	**6.60**	9.34	15.94	Bn, Super	------	------	2.59	----------	2.59	------	2.59	------	----
----	*8.00*	*7.00*	*15.00*		------	------	*2.50*	Bl, Bn, T	*2.50*	------	*2.50*	------	----
1099	------	------	9.12	Bn, Super	------	------	6.36	----------	**6.36**	------	7.53	------	----
----	------	------	*9.00*		------	------	*7.00*	Bl, Bn, T	*7.00*	------	*7.50*	------	----
1100	9.85	0.80	10.65	Bn, G, Super	1.67	------	2.21	----------	**3.88**	------	5.91	------	0.66
	8.00	*2.00*	*10.00*		*2.00*	------	*2.50*	Bl, Bn, G, T	*4.50*	------	*5.00*	------	----
1116	9.58	0.61	10.19	Bn, G. Super	0.68	------	1.06	----------	1.74	------	10.31	------	0.80
----	*8.00*	*2.00*	*10.00*		*0.50*	------	*1.00*	Bn, Bl,, T	*1.50*	------	*10.00*	------	----
1017	9.04	2.67	11.71	Bat G, Bn, Super	0.86	------	2.89	----------	**3.75**	------	2.32	------	0.83
----	*8.00*	*2.00*	*10.00*		*0.50*	------	*3.50*	Bat G, Bl, Bn, T	*4.00*	------	*2.00*	------	----
1063	8.12	1.87	9.99	------	------	1.49	2.64	----------	4.13	------	2.25	------	----
1101	9.68	1.11	10.79	------	0.23	1.62	2.39	----------	4.24	------	2.22	------	----
1187	9.40	1.24	10.64	Bn, G, Super	------	1.30	2.69	----------	3.99	------	2.10	------	----
----	*8.00*	*2.00*	*10.00*		------	*1.50*	*2.50*	Bl, Bn, G, T	*4.00*	------	*2.00*	------	----
1166	11.02	2.11	13.33	------	2.20	------	2.08	----------	4.28	------	1.85	------	1.12
1208	9.11	0.55	9.66	Bn, Super	2.20	------	2.15	----------	4.35	------	2.55	------	----
----	*8.00*	*2.00*	*10.00*		*2.00*	------	*2.00*	Bl, Bn, T	*4.00*	------	*2.00*	------	----

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Armour Fertilizer Works, Los Angeles, Cal.—Continued.		
983	Sulfate of Potash	Arlington Heights Ft. Co., Riverside	59.77
984	do	do	59.98
	Sold on Station analysis.		
1066	Sulfate of Potash	J. C. Boyd, Rialto	**55.10**
	Guaranteed		*57.60*
1016*	Tankage	I. W. Freeman, Redlands	28.47
	Guaranteed		*29.00*
1067*	Tankage	E. J. Oatman, Riverside	25.52
	Sold on Station analysis.		
1085*	Tankage	J. S. Edwards, E. Highland	31.61
1172*	do	W. T. Henderson, Riverside	31.18
	Guaranteed		*30.80*
1132*	Tankage	V. W. Baker, Lordsburg	27.68
	Guaranteed		*27.40*
	California Fertilizer Works, San Francisco, Cal.		
1175	Fruit, Orange and Vine	J. H. Williams, Porterville	27.62
	Guaranteed		*26.20*
1004	High Grade Special Superphosphate	J. D. Farwell, Los Gatos	26.90
	Guaranteed		*28.98*
1167	Nursery Stock	J. P. Brown, Riverside	27.67
	Guaranteed		*24.75*
1083	Special	Miss R. C. Johnson, San José	30.15
	Guaranteed		*28.72*
1115	Special Fruit and Vine	William E. Wilson, Exeter	24.84
1118	do	do	25.21
	Guaranteed		*24.15*
1174	Special High Grade	J. H. Williams, Porterville	29.60
	Guaranteed		*29.05*
1086	Special Nursery Stock	G. A. Hanson, Upland	24.74
	Guaranteed		*24.75*
1137	Special Nursery Stock	J. P. Brown, Riverside	29.31
	Guaranteed		*30.96*
1173	Special Orange and Lemon	J. P. Brown, Riverside	26.61
	Guaranteed		*26.38*
1087	Special Orange Tree	G. A. Hanson, Upland	26.13
1123	do	William Osborn, Upland	25.18
	Guaranteed		*26.50*
	Cudahy Packing Company, South Omaha, Neb.		
1111	Blood and Bone	National Orange Co., Riverside	27.53
	Guaranteed		*27.90*
	Maier Fertilizer Co., Los Angeles, Cal.		
1039	"A A"	George Haney, Highland	25.14
	Guaranteed		*25.00*
1051	"A A"	Pattie & Lett Co., Riverside	25.80
	Guaranteed		*25.40*
1040	"A A"	George Haney, Highland	27.87
1069	do	G. H. Wheeler, Bloomington	27.90
	Guaranteed		*27.60*
1068	"T"	G. H. Wheeler, Bloomington	20.65
	Guaranteed		*21.80*

*1016—65 per cent fine.
*1067—70 per cent fine.
*1085—70 per cent fine.
*1172—73 per cent fine.
*1132—77 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds Per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
983											49.81		
984											49.98		
1066											**45.92**		1.96
											48.00		
1016			16.34				4.53		**4.53**				
			15.00				*5.00*		*5.00*				
1067			10.18				5.11		5.11				
1085			5.22				8.07		8.07				
1172			4.85				8.03		8.03				
			4.50				*8.00*		*8.00*				
1132			12.89				5.11		5.11				
			13.00				*5.00*		*5.00*				
1175	**7.29**	2.93	10.22	Bn, Super	0.59	0.45	1.35		2.39		7.48		0.78
	6.00	*3.50*	*9.50*		*0.50*		*2.00*	Bl, Bn	*2.50*		*7.00*		
1004	**10.98**	5.77	16.75				3.01		**3.01**				
	13.00	*3.00*	*16.00*				*3.30*		*3.30*				
1167	8.81	5.47	14.28	Bn, Super	0.82	0.62	1.70		**3.14**		2.75		0.52
	7.00	*3.00*	*10.00*		*0.50*		*3.00*	Bl, Bn	*3.50*		*2.00*		
1083	6.97	7.23	14.20	Bn, Super	1.94		1.45		3.39		5.46		0.74
	6.50	*7.50*	*14.00*		*0.55*		*2.60*	Bl, Bn	*3.15*		*5.00*		
1115	6.15	3.61	9.76		0.78	0.72	1.13		2.63		5.35		0.76
1118	6.78	2.92	9.70	Bn, Super	0.76	0.74	1.29		2.79		4.84		0.92
	6.00	*4.00*	*10.00*		*0.35*		*2.50*	Bl, Bn	*2.85*		*4.00*		
1174	6.59	2.91	9.50	Bn, Super	0.63	0.22	1.32		**2.17**		10.51		0.58
	6.00	*2.00*	*8.00*		*0.50*		*2.00*	Bl, Bn, T	*2.50*		*10.00*		
1086	**5.81**	4.96	10.77		0.73	0.86	1.90		3.49		2.45		0 80
	7.00	*3.00*	*10.00*	Super	*0.50*		*3.00*	Bl, Bn	*3.50*		*2.00*		
1137	**8.53**	3.94	12.47		2.33		1.75		4.08		2.59		
	10.50	*3.00*	*13.50*	Super	*1.00*		*3.10*	Bl, Bn	*4.10*		*2.00*		
1173	7.15	3.57	10.72		0.82	0.22	1.68		**2.72**		5.58		1.40
	7.00	*2.50*	*9.50*	Super	*0.25*		*2.75*	Bl, Bn	*3.00*		*5.00*		
1087	5.85	3.88	9.73		0.67	0.78	1.12		2.57		6.77		1.04
1123	**5.41**	2.95	8.36		1.28		1.06		2.34		7.64		0.96
	6.50	*2.50*	*9.00*	Super	*0.25*		*2.25*	Bl, Bn	*2.50*		*7.10*		
1111	**3.91**	9.03	12.94				5.39		5.39				
	7.00	*5.00*	*12.00*				*5.00*		*5.00*				
1039			11.02				4.80		4.80		**1.24**		
			10.00	Bn, T			*5.00*	Bl, Bn, T	*5.00*		*2.00*		
1051			**10.97**				4.48		4.48		**1.49**		0.56
			12.00	Bn, T			*4.00*	Bl, Bn, T	*4.00*		*2.00*		
1040	**6.85**	5.92	12.77				4.34		4.34		1.62		
1069	**5.93**	6.95	12.88				4.54		4.54		1.56		
	8.00	*4.00*	*12.00*	Bn, T			*4.00*	Bl, Bn, T	*4.00*		*2.00*		
1068	**5.87**	6.47	12.34				3.05		3.05				
	8.00	*6.00*	*14.00*	Bn, T			*3.00*	Bl, Bn, T	*3.00*				

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Mapes Formula and P. G. Co., New York.		
1042	Mapes Fruit and Vine	J. J. Prendergast, Redlands	29.11
	Guaranteed		*24.58*
1041	Mapes Orange Tree Manure	J. J. Prendergast, Redlands	24.69
	Guaranteed		*22.96*
	Mountain Copper Co., San Francisco, Cal.		
1176	Mixed Fertilizer	J. H. Williams, Porterville	22.40
1193	do	E. W. Slade, Rialto	20.04
	Guaranteed		*19.20*
1088	Superphosphate	Sparr Fruit Co., Riverside	24.53
	Guaranteed		*24.25*
1141	Superphosphate	W. H. Jameson, Corona	21.70
1142	do	Corona Lemon Co.	21.52
	Guaranteed		*21.36*
1143	Superphosphate	W. H. Jameson, Corona	22.16
	Guaranteed		*21.60*
	Pacific Bone, Coal and Fert. Co., San Francisco, Cal.		
1114	Citrona	Wm. E. Wilson, Exeter	29.71
	Guaranteed		*28.65*
	Pacific Guano and Fert. Co., San Francisco, Cal.		
1052	Fruit and Vine	F. L. Palmer, North Pomona	29.45
1093	do	A. E. Bennett, Tustin	30.10
	Guaranteed		*29.26*
1032	High Grade Nursery	A. S. Fox, Colton	42.99
	Guaranteed		*42.00*
986	Nursery Stock	J. E. Heath, Covina	31.32
1022	do	do	30.47
1033	do	A. S. Fox, Colton	29.69
1053	do	F. L. Palmer, North Pomona	31.14
1055	do	do	28.59
1054	do	H. C. Rumohr, Redlands	30.79
1188	do	A. E. Bennett, Tustin	30.84
	Guaranteed		*28.80*
985	Special	J. E. Heath, Covina	28.99
	Guaranteed		*25.70*
1005	Special	J. M. Riley, Los Angeles	32.04
	Guaranteed		*29.70*
1023	Special	J. E. Heath, Covina	31.31
	Guaranteed		*27.30*
1157	Special Fertilizer	J. M. Riley, Los Angeles	33.87
	Guaranteed		*34.15*
	Carroll B. Smith, Redlands.		
1109	Bat Guano	Wright Bros., Riverside	25.36
1134	do	D. Durkee, San Dimas	31.56
	Sold on Station analysis.		
1007*	Bone Meal	Carroll B. Smith, Redlands	30.39
	Guaranteed		*24.70*
1028	Bone Meal	Bartlett & Duley, Upland	29.43
	Guaranteed		*29.18*
1156*	Special	Carroll B. Smith, Redlands	36.54
	Guaranteed		*36.60*

*1007—32 per cent fine.
*1156—66 per cent fine.
*1008—65 per cent fine.
*1076—50 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds Per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
1042	5.57	2.82	8.39		1.34	0.15	0.54		2.03		11.76		1.04
	5.00	*2.00*	*7.00*	Bn, G	*1.20*	*0.15*	*0.30*	G	*1.65*		*10.00*		
1041	5.44	3.57	9.01		2.06	0.46	0.80		3.32		4.19		1.04
	6.00	*2.00*	*8.00*	Bn, G	*2.40*	*0.15*	*0.75*	G	*3.20*		*3.00*		
1176	14.42	0.74	15.16								4.25		
1193	12.51	1.03	13.54								4.19		
	12.00	*0.50*	*12.50*								*4.00*		
1088	20.44	0.38	20.82										
	20.00	*0.50*	*20.50*										
1141	18.08	1.42	19.50										
1142	17.93	1.47	19.40										
	17.80	*1.20*	*19.00*										
1143	18.47	1.03	19.50										
	18.00	*1.20*	*19.20*										
1114	8.29	1.99	10.28		1.71	0.06	1.29		3.06		6.89		0.76
	7.00	*3.00*	*10.00*	Bn, Super	*1.50*		*1.50*	Bl, Bn, T	*3.00*		*7.00*		
1052	9.25	1.63	10.88		0.84	0.19	1.58		2.61		6.99		
1093	8.16	1.66	9.82		1.15	0.12	1.68		2.95		7.68		0 82
	8.00	*2.50*	*10.50*	Bn, Super	*0.85*		*2.00*	Bl, Bn	*2.85*		*7.00*		
1032	13.58	0.05	13.63			5.11	0.98		6.09		3.95		0 50
	13.00			Super		*5.00*	*1.00*	Fs	*6.00*		*4.00*		
986	10.92	2.03	12.95		1.90		2.23		4.13		2.41		0.62
1022	11.16	2.56	13.72		1.17		2.63		3.80		2.06		1.00
1033	8.95	4.19	13.14		1.60		2.43		4.03		2.35		1.14
1053	11.11	2.22	13.33		1.03	0.10	2.83		3.96		2.29		
1055	9.05	3.28	12.33		1.19	0.19	2.44		3.82		2.24		
1054	10.22	3.10	13.32		1.27		2.88		4.15		2.01		0 68
1188	9.98	2.68	12.66		1.51		2.53		4.04		2.86		0 88
	9.00	*3.00*	*12.00*	Bn, Super	*1.00*		*3.00*	Bl, Bn, Fs	*4.00*		*2.00*		
985	11.77	1.37	13.14				1.41		1.41		7.58		.56
	10.00	*2.00*	*12.00*	Bn, Super			*1.00*	Bl, Bn	*1.00*		*8.00*		
1005	10.56	1.77	12.33		2.50		.78		3.28		6.18		.80
	9.00	*3.00*	*12.00*	Bn, Super	*2.00*		*1.00*	Bl, Bn	*3.00*		*6.00*		
1023	11.00	2.13	13.13		2.39		0.89		3.28		4.96		.72
	9.00	*3.00*	*12.00*	Bn, Super	*2.00*		*1.00*	Bl, Bn	*3.00*		*4.00*		
1157	8.69	4.21	12.90		1.54		2.43		3.97		6.25		1 20
	8.00	*2.50*	*10.50*	Bn, Super	*1.00*		*3.00*	Bl, Bn, G, Fs	*4.00*		*6.00*		
1109			11.45						4.32		.54		
1134			10.42						4.95		.45		
1007			21.16				3.96		3.96				
			16.00				*3.50*		*3.50*				
1028	8.53	11.20	19.78				3.98		3.98				
	8.00	*12.63*	*20.63*				*3.90*		*3.90*				
1156			9.85				8.43		**8.43**				
			7.50				*9.00*		*9.00*				

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Carroll B. Smith, Redlands—Cont.		
1008*	Tankage	Carroll B. Smith, Redlands	**15.74**
	Guaranteed		*18.01*
1076*	Tankage	G. B. Ferguson, Colton	31.10
	Guaranteed		*29.26*
	Swift & Co., Chicago.		
1077	Blood	McIntyre Cement Co., Riverside	51.80
1138	do	E. L. Korthen, Riverside	51.50
1197	do	G. W. Griffiths, Jr., Covina	51.99
	Guaranteed		*48.10*
989*	Swift's Bone Meal	W. E. Gaul, San Dimas	29.63
	Guaranteed		*24.39*
1079*	Special Bone Meal	McIntyre Cement Co., Riverside	29.56
1198*	do	G. W. Griffiths, Jr., Covina	30.15
	Guaranteed		*25.99*
1034*	Diamond "C"	Bartlett & Duley, Upland	30.91
1154*	do	E. L. Korthen, Riverside	29.19
	Guaranteed		*28.40*
1006*	Diamond "E"	C. B. Smith, Redlands	32.21
1035*	do	Bartlett & Duley, Upland	32.81
1078*	do	McIntyre Cement Co., Riverside	32.12
1139*	do	E. L. Korthen, Riverside	31.97
1199*	do	G. W. Griffiths, Jr., Covina	33.17
	Guaranteed		*32.00*
1153	Diamond "G"	C. B. Smith, Redlands	33.15
1163*	do	L. C. Waite, Riverside	33.07
	Guaranteed		*32.25*
1144	Diamond "H"	E. L. Korthen, Riverside	31.00
	Guaranteed		*27.39*
1124	Diamond "I"	L. C. Waite, Riverside	33.16
	Guaranteed		*34.29*
	Union Fertilizer Co., Los Angeles, Cal.		
1018*	Bone Meal	E. E. Cole, Redlands	27.09
	Guaranteed		*24.40*
1056*	Bone Meal	J. F. Jackson, Riverside	29.27
1070*	do	W. L. May, Rialto	29.34
1125*	do	H. W. Pierce, Claremont	30.08
	Guaranteed		*27.29*
1089*	Bone Meal	I. W. Freeman, Upland	26.20
	Guaranteed		*25.90*
1190*	Bone Meal	Whittier Implement Co., Whittier	29.00
	Guaranteed		*24.40*
1108	Dissolved Guano	Wright Bros., Riverside	24.61
	Sold on Station Analysis.		
1020	Fruiting	E. E. Cole, Redlands	26.23
	Guaranteed		*24.17*
1019	Fruiting	E. E. Cole, Redlands	24.28
1021	do	C. A. Miller, Highland	27.91
1058	do	J. F. Jackson, Riverside	29.75
1090	do	I. W. Freeman, Upland	28.35
1195	do	W. L. May, Rialto	26.20
1126	do	H. W. Pierce, Claremont	29.19
	Guaranteed		*23.32*

* 989—56 per cent fine.
*1163—Some hoof.
*1034—57 per cent fine.
*1070—47 per cent fine.
*1035—45 per cent fine.
*1190—37 per cent fine.
*1199—70 per cent fine.
*1198—48 per cent fine.
*1056—42 per cent fine.
*1006—50 per cent fine.
*1089—42 per cent fine.
*1139—70 per cent fine.
*1079—74 per cent fine.
*1018—49 per cent fine.
*1154—60 per cent fine.
*1125—37 per cent fine.
*1078—75 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
1008			**4.59**				3.55		3.55				
			7.00				*3.65*		*3.65*				
1076			22.00				3.97		3.97				
			20.00				*3.90*		*3.90*				
1077							14.00		14.00				
1138							13.92		13.92				
1197							14.05		14.05				
							13.00		*13.00*				
989			30.88				1.45		1.45				
			27.00				*0.82*		*0.82*				
1079			**25.78**				2.63		2.63				
1198			30.12				1.78		1.78				
			29.00				*0.82*		*0.82*				
1034			25.80				3.02		3.02				
1154			26.46				2.36		2.36				
			25.00	Bn			*2.47*	Bn	*2.47*				
1006			21.46				4.60		**4.60**				
1035			24.14				3.97		**3.97**				
1078			20.94				4.52		**4.52**				
1139			20.54				4.57		**4.57**				
1199			21.10				4.79		4.79				
			19.00	Bn			*4.94*	Bl, Bn, T	*4.94*				
1153			21.20				2.88		**2.88**		5.33		
1163			22.04				2.96		**2.96**		**4.48**		
			19.00	Bn			*3.25*	Bn	*3.25*		*5.00*		
1144			17.70				3.67		3.67		3.63		
			16.00	Bn, T			*2.88*	Bn, T	*2.88*		*4.00*		
1124			19.74				3.78		3.78	5.66			4.10
			18.75	Bn			*3.91*	Bn	*3.91*		*5.00*		
1018			25.96				1.86		1.86				
			22.00				*2.00*		*2.00*				
1056			22.86				3.23		3.23				
1070			23.98				2.99		2.99				
1125			23.70				3.27		3.27				
			22.00				*2.85*		*2.85*				
1089			25.70				1.66		1.66				
			26.00				*1.50*		*1.50*				
1190			27.16				2.14		2.14				
			22.00				*2.00*		*2.00*				
1108	20.51	0.37	20.88										
1020	7.52	3.76	11.28	Bn, G, Super T	1.19	0.13	1.83		3.15		3.61		0.60
	7.00	*2.00*	*9.00*		*0.75*	*0.60*	*1.65*	Bn, G, T	*3.00*		*3.50*		
1019	8.14	2.36	10.50		0.47	0.24	2.04		**2.75**		2.98		0.80
1021	7.45	2.14	9.59			0.06	3.91		3.97		3.01		1.10
1058	8.81	0.91	9.72		0.08	0.04	4.16		4.28		2.80		0.82
1090	7.91	1.99	9.90		0.03	0.08	3.84		3.95		3.04		0.90
1105	7.31	2.25	9.56		0.63	0.27	2.72		3.62		2.88		
1126	8.74	2.16	10.90		1.54	0.20	2.06		3.80		4.50		0.90
	7.00	*1.50*	*8.50*	Bn, G, Super T	*0.75*	*0.60*	*1.65*	Bn, G, T	*3.00*		*3.00*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Union Fertilizer Company, Los Angeles, Cal.—Continued.		
1036	Fruiting	J. B. Hanna, Colton	27.24
1057	do	J. F. Jackson, Riverside	27.29
1191	do	Whittier Implement Co., Whittier	28.80
	Guaranteed		*23.58*
1127	Nitrate of Soda	H. W. Pierce, Claremont	52.14
1145	do	W. H. White, Glendora	51.81
1194	do	W. L. May, Rialto	52.21
	Guaranteed		*49.50*
1091	Nursery	I. W. Freeman, Upland	29.23
	Guaranteed		*27.70*
1192	Nursery	W. L. May, Rialto	29.72
	Guaranteed		*27.45*
1117	Special Fruiting	Steward Citrus Association, Upland	33.46
	Guaranteed		*28.65*
1155	Special Fruiting	E. E. Cole, Redlands	30.30
	Guaranteed		*29.50*
	T. C. Wallace, Riverside, Cal.		
1177	Blood	Wilcox, Rose Co., Colton	48.40
	Guaranteed		*48.10*
1010*	Big 2 Bone	Haight, Bethel Co., Redlands	31.75
1011*	do	do	32.20
	Guaranteed		*29.40*
1094*	Big 2 Bone	L. S. Flatan, Redlands	31.75
	Guaranteed		*29.30*
1105*	Big 2 Bone	E. T. Watson, Redlands	31.00
	Guaranteed		*30.90*
1178*	Pacific Big 2	Wilcox, Rose Co., Colton	28.82
	Guaranteed		*30.10*
1135*	Pacific Big 4	C. H. Low, Riverside	38.27
1179*	do	Wilcox, Rose Co., Colton	37.18
	Guaranteed		*37.95*
	Woodbridge Chemical Works, San Bernardino.		
1080	Citrus A	John Murphy, Redlands	28.45
	Guaranteed		*27.17*
1081	Citrus B	Factory	19.44
	Guaranteed		*20.60*
1046	Special Vegetable	Factory	25.79
	Guaranteed		*25.90*
1082	Woodbridge O. & L., No. 1	Factory	29.78
	Guaranteed		*28.38*
	Woodbridge Fertilizer Co., Los Angeles.		
1106	Grape Fruit	W. Nye, Highland	20.30
	Guaranteed		*20.50*
1045	Special	Warehouse, Colton	22.83
	Guaranteed		*22.45*
1092	Woodbridge Special	W. Nye, Highland	20.05
	Guaranteed		*18.90*

*1010—72% fine. Improperly labeled.
*1011—69% fine. Improperly labeled.
*1094—77% fine. Improperly labeled.
*1105—68% fine. Improperly labeled.
*1178—73% fine. Some hoof.
*1135—83% fine. Improperly labeled.
*1179—83% fine. Some hoof.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Pounds per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
1036	6.89	3.61	10.50		1.41	0.12	1.99		3.52		4.09		0.56
1057	7.08	3.38	10.46		0.37		3.50		3.87		2.74		0.80
1191	8.29	1.85	10.14	Bn, G, Super T		0.12	3.85		3.97		3 03		0.92
	7.00	*2.00*	*9.00*		*0.75*	*0.60*	*1.65*	Bn, G, T	*3.00*		*3.60*		
1127					15.80				15.80				
1145					15.70				15.70				
1194					15.82				15.82				
					15.00				*15.00*				
1091	5.73	6.30	13.03		0.10		4.80		4.90		1.33		0.68
	6.00	*2.00*	*8.00*	Bn, G, Super T	*1.00*	*1.00*	*3.00*	Bn, G, T	*5.00*		*1.50*		
1192	7.29	1.82	9.11		2.16	0.25	2.66		5.07		2.04		
	6.00	*1.50*	*7.50*	Bn, G, Super T	*1.00*	*1.00*	*3.00*	Bn, G, T	*5.00*		*1.50*		
1117	10.82	3.92	14.74		0.74	0.22	2.83		3.79		4.25		0.54
	8.00	*1.50*	*9.50*	Bn, G, Super T	*1.00*	*0.75*	*2.25*	Bn, G, T	*4.00*		*3.50*		
1155	8.96	0.51	9.47		2.29	0.71	1.22		4.22		3.98		
	8.00	*2.00*	*10.00*	Bn, G, Super T	*1.00*	*0.75*	*2.25*	Bn, G, T	*4.00*		*4.00*		
1176							13.08		13.08				
							13.00		*13.00*				
1010			28.76				2.57		2.57				
1011			27.08				3.10		3.10				
			28.00				*2.06*		*2.06*				
1094			29.28				2.45		2.45				
			26.00				*2.50*		*2.50*				
1105			**24.94**				3.25		3.25				
			28.00				*2.50*		*2.50*				
1178			26.38				2.27		2.27				
			27.00	Bn			*2.50*		*2.50*				
1135			5.00				10.08		10.08				
1179			4.58				9.86		9.86				
			5.50				*9.87*	Bn, T	*9.87*				
1080	4.72	7.30	12.02	Bn, G	1.22		2.73		3.95			4.40	2 06
	5.00	*5.00*	*10.00*	Super	*1.75*		*2.25*	Bl,Bn,G,T	*4.00*		*4.00*		
1081	**2.13**	8.45	10.58				2.52		2.52			3.40	2.44
	5.00	*5.00*	*10.00*	Bn			*2.50*	Bl, Bn, G	*2.50*		*3.00*		
1046	**2.81**	7.09	9.90	Bn,	0.85		2.63		3.48		**5.50**		
	6.00	*2.00*	*8.00*	Super	*1.00*		*2.00*	Bl, Bn, G	*3.00*		*6.00*		
1082	4.60	7.23	11.87		1.01		3.49		4.50			**3.96**	2.26
	5.00	*5.00*	*10.00*	Bn	*1.75*		*2.25*	Bl,Bn, G,T	*4.00*	*2.50*	*2.50*	*5.00*	
1106			7.36	Bn,	0.14		1.96		2.10		5.77		
			8.00	Super	*1.00*		*1.00*	Bl, Bn, G	*2.00*		*6.00*		
1045			11.01	Bn,	0.50	0.04	2.04		2.58		4.07		
			11.00	Super	*0.50*		*2.00*	Bl, Bn, G	*2.50*		*4.00*		
1092			8.76		0.19		2.00		2.19			4.34	1.24
			9.00	Bn, Super	*1.00*		*1.00*	Bl, Bn, G	*2.00*		*4.00*		

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1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-1903.
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No. 2—Catalogue of the Ephydridæ.

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COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

COMMERCIAL FERTILIZERS.

By JOHN S. BURD.

BULLETIN No. 194.

(Berkeley, Cal., December 31, 1907.)

SACRAMENTO

W. W. SHANNON, : : : : SUPERINTENDENT STATE PRINTING

1908

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The Station publications (REPORTS AND BULLETINS), *so long as available, will be sent to any citizen of the State on application.*

COMMERCIAL FERTILIZERS.

By JOHN S. BURD.

In the attempt to make each of the publications of the Fertilizer Control complete in itself, considerable material has necessarily to be repeated throughout the series. The repetition, however, of certain kinds of information is now considered to be no longer necessary. In order to make such information always available, separate circulars have been prepared covering directions for sampling, methods of reporting results, requirements necessary to obtain analyses, and interpretation of reports. Copies of these circulars will be sent to all persons known by us to be consumers of fertilizers and to all others who may apply for the same.

The present bulletin comprises the results of fertilizer inspection work for the first half of the fiscal year 1907–08.

REGISTERED MANUFACTURERS AND DEALERS.

The following manufacturers and dealers in commercial fertilizers have obtained certificates of registration under the provisions of the California Fertilizer law, for the fiscal year beginning July 1, 1907. A list is also given of the brands of fertilizers and fertilizer materials offered by them for sale. According to the sworn returns of dealers registered for the fiscal year ending June 30, 1907, their entire sales in the State amounted to 21,647 tons.

No dealer or manufacturer, except those who have certificates of registration from the University of California, and their authorized agents, can legally sell fertilizers in this State. No person or company has any right to use any registration number except in connection with the firm name to which the registration certificate of such number has been issued; and no person or company to whom a registration number has been assigned has any right to give any other person or company permission to use said registration number, and any number so used is a fraud. No agent has any right to use his principal's registration number in connection with his own name.

Agricultural Chemical Works, Los Angeles, Cal.

Registration No. 8.

Apricot.
Bat Guano.
Blood.
Bone
Grape and Berry.
Gypsum.
Potato.
Prune and Peach.
Special Orange and Lemon for Heavy Soil.
Special Orange and Lemon for Light Soil.
Special Orange and Lemon for Non-fruiting Trees.

Lawn and Rose.
Muriate of Potash.
Nitrate of Soda.
No. 1 Orange and Lemon.
Olive.
Sulfate of Potash.
Superphosphate.
Tankage.
Vegetable.
Walnut and Almond.

Special mixtures to order of consumers.

American Agricultural Chemical Co., California Works, Los Angeles, Cal.

Registration No. 1.

Acid Phosphate.
Bat Guano.
Blood
Fruit and Vine.
Ground Bone.
Lawn.
Lemon Tree.
Nitrate of Soda.
Nursery Stock.
Orange and Lemon.
Special Fruit and Vine.
Sulfate of Potash.
Special Brands to Order.
Vegetable.

The Armour Fertilizer Works, Los Angeles, Cal.

Registration No. 7.

Acid Phosphate.
Acidulated Bone Meal.
Bone Meal.
Bone Flour.
Bone, Blood and Potash
Concentrated Superphosphate.
Dried Blood.
Flower and Fern Food.
Fruit Special.
Fruit and Vine Fertilizer.
Guano.
Lawn and Garden Fertilizer.
Nitrate of Soda.
Orange Tree Manure.
Pea Special.
Special 5-8-2.
Sulfate of Ammonia.
Sulfate of Potash.
Tankage.

Special mixtures to order of consumers.

F. W. Braun, Los Angeles, Cal.

Registration No. 35.

Acid Phosphate
Muriate of Potash.
Nitrate of Soda.
Sulfate of Ammonia.
Sulfate of Potash.
Superphosphate.

Balfour, Guthrie & Co., San Francisco, Cal.

Registration No. 10.

Nitrate of Soda.
Sulfate of Potash.
Thomas Phosphate Powder.

California Fertilizer Works, Inc., San Francisco, Cal.

Registration No. 3.

Fruit and Vine.
Fruit and Vine Fertilizer.
Fruit, Orange and Vine.
Special Fruit and Vine.
High Grade Ammoniated Bone Superphosphate.
High Grade Bone Meal.
Hop.
Lemon Tree (M).
Nursery Stock.
Nursery Stock Fertilizer.
Odorless Lawn Dressing.
Orange Tree (B).
Special Orange Tree.
Peach.
Peach Fertilizer.
Special Fertilizer with Iron Sulfate.
Special Fertilizer.
Special Orange and Lemon.
Special Phosphate and Potash.
Special Sugar.
Truck and Berry.

Special mixtures to order of consumers.

Cudahy Packing Co., South Omaha, Neb.

Registration No. 16.

Tankage, otherwise designated Blood and Bone.

Hauser Packing Co., Los Angeles, Cal.

Registration No. 33.

Dried Blood. Tankage.

Hawaiian Fertilizer Co. Ltd., San Francisco, Cal.

Registration No. 19.

Blood.
Guano.
Muriate of Potash.
Nitrate of Soda.
Sulfate of Potash.
Phosphate.
Tankage.

Special mixtures to order of consumers.

R. A. Holcombe & Co., San Francisco, Cal.

Registration No. 27.

Diamond "H" Nitrate of Soda.

Mapes Formula and Peruvian Guano Co., New York.

J. J. Prendergast, Redlands, agent.

Registration No. 12.

Mapes Fruit and Vine Manure.
Mapes Vegetable Manure.
Mapes Orange Tree Manure.

Morris & Co., Chicago.

Thos. C. Wallace, Riverside, Agent.

Registration No. 26.

Pacific Big One.
Pacific Big Two.
Pacific Big Three.
Pacific Big Four.
Pacific Big Five.
Pacific Big Six.
Pacific Big Seven.
Pacific Big Eight.
Bone Meal.
Dried Blood.
Tankage.

The Mountain Copper Co., San Francisco, Cal.

Registration No. 28.

Mococo Superphosphates.
" Mixed Fertilizers of various compositions.
" Special mixtures to order of consumers.
Nitrate of Soda.
Sulfate of Potash.

Oakland Meat and Packing Co., Stock Yards, Cal.

Registration No. 24.

Special Fertilizer.

Pacific Bone, Coal and Fertilizing Co., San Francisco, Cal.

Registration No. 14.

Ceres Brand.
Citrona Brand.
Nitrate of Soda.
Pomona Brand.
Lupine Brand.
Thomas Phosphate Powder.

Special mixtures to order of consumers.

Pacific Guano and Fertilizer Co., San Francisco, Cal.

Registration No. 4.

Dissolved Bone Meal.
Raw Bone Meal.
Steamed Bone Meal.
Double Manure Salt.
Dried Blood.
Fish Scrap.
Fruit and Vine.
(OO) Grape Fertilizer.
Kainit.
Ohlandt's Lawn Dressing.
Muriate of Potash.
Nitrate of Soda.
Nursery Stock.
(N) Orange and Lemon.
(NN) Orange and Lemon.
(O) Peach, Almond and Prune.
Special Phosphate and Potash.
Sulfate of Ammonia.
Sulfate of Potash.
Superphosphate.
Double Superphosphate.
Tankage No. 1.
Tankage No. 2.
Thomas Phosphate Powder.
(OOO) Vegetable Grower.

Redlands Fruit Association, Redlands, Cal.

Registration No. 34.

Blood.
Bone.
Nitrate of Soda.
Tankage.

Carroll B. Smith, Redlands, Cal.

Registration No. 25.

Blood.
Bone Meal.
Guano.
Sulfate of Potash.
Nitrate of Soda.
Tankage.
Thomas Phosphate Powder.

Special mixtures to order of consumers.

Swift & Co,, Chicago, Ill.

Registration No. 5.

Swift's Diamond "A" Fertilizer.
Swift's Diamond "B" Fertilizer.
Swift's Diamond "C" Fertilizer.
Swift's Diamond "D" Fertilizer.
Swift's Diamond "E" Fertilizer.
Swift's Diamond "G" Fertilizer.
Swift's Diamond "H" Fertilizer.
Swift's Diamond "I" Fertilizer.
Swift's Diamond "J" Fertilizer.
Swift's Ground Dried Blood.
Swift's Special Acidulated Bone.
Swift's Special Bone Meal.

Union Fertilizer Co., Los Angeles, Cal.

Registration No. 9.

Blood.
Blood and Bone.
Bone Meal.
Guano.
Phosphate.
Superphosphate.
Fruiting.
Special Fruiting.
Lawn.
Nitrate of Soda.
Nursery.
Sulfate of Potash.
Tankage.

Special fertilizers to order of consumers.

Union Superphosphate Co., San Francisco, Cal.

Registration No. 31.

Superphosphate.

Western Meat Co., San Francisco, Cal.

Registration No. 11.

W. M. Co. Dry Ground Tankage.
W. M. Co. Raw Bone Meal.
Special Bone Meal.

The Woodbridge Chemical Works, San Bernardino, Cal.

Registration No. 15.

Citrus A.
Citrus B.
Lawn and Rose.
Orange and Lemon No. 1.
Potato.
Special Lemon.
Special Nursery.
Summer Special.

Woodbridge Fertilizer Co., Los Angeles, Cal.

Registration No. 22.

Blood.
Bone Meal.
Citrus B.
Lemon Special.
Nitrate of Soda.
Orange No. 1.
Sulfate of Potash.
Superphosphate.
Tankage.

X. L. O. Grease Co., San Francisco, Cal.

Registration No. 32.

Fertilo.

SCOPE OF INSPECTION.

From July 1, to December 30, 1907, 258 samples of fertilizers and fertilizing materials have been received at the laboratory. Of this number 9 were sent by farmers under the two-dollar fee provision, 66 were taken by inspectors from purchasers' goods upon the request of the purchasers, and 166 were taken by inspectors from goods in the hands of agents and manufacturers. On 34 samples the analysis as reported was used as a basis of settlement by mutual agreement of buyer and seller. No guaranty was required or given with goods sold under such an agreement. Seventeen samples of a miscellaneous nature which do not come within the legal definition of a commercial fertilizer, are omitted from the tables.

The following classification may be made of samples reported in this bulletin:

Complete fertilizers	110
Bone meal	33
Tankage	32
Nitrogenous superphosphate	1
Superphosphate and potash	1
Superphosphate	38
Dried Blood	10
Nitrate of Soda	7
Sulfate of Potash	4
Bat guano	4
Bat guano and gypsum	1
Total	241

DEFICIENCIES.

In the analyses of the above samples, the following number of deficiencies greater than allowed by law occur:

Available phosphoric acid (total when available is not guaranteed)	30
Total nitrogen	27
Potash	5
In valuation	17

These deficiencies were found in 56 samples.

The fertilizer law allows a deficiency of 0.25 per cent in nitrogen, 0.50 per cent in potash, and 1.00 per cent in available phosphoric acid.

FERTILIZER VALUATIONS.

The calculations of the commercial values of the fertilizers here reported are made on the so-called unit basis. Such calculations consist simply in multiplying the number of per cent of each ingredient by the price per unit and adding the products. The sum thus obtained is the commercial value per ton at the prices used. If it is desired to use such a calculation for determining the amount which should be paid for goods, or the rebate to which the buyer is entitled owing to the goods delivered being below the guaranty, it can only be satisfactorily done if a definite price per unit has been agreed upon between buyer and seller. But for the mere purpose of showing the relative values of goods to guaranties, it is not at all necessary that the prices adopted should be the exact market prices. Thus it is that the Fertilizer Control in attempting to show the relation between values found and values claimed, uses a schedule which is admittedly only an approximate average of market values. Owing to market fluctuations, differences in cost of delivery at different points, and other causes, the obtaining of true average market prices is an impossibility. But if the reader will bear in mind the true purpose of the valuations reported, these will have served their turn and he will not be led to assume that the Experiment Station is dictating the prices at which goods shall be sold.

SCHEDULE OF TRADE VALUES.

	Cents. Per Pound.	Value. Per Unit.
Phosphoric Acid.		
Available (water and citrate-soluble)	6	$1 20
Insoluble in mixed fertilizers	2½	0 50
In fine* bone and tankage	4½	0 90
In medium* bone and tankage	3½	0 70
In fine* Thomas phosphate powder	5	1 00
In medium* Thomas phosphate powder	3	0 60
Nitrogen.		
In ammonia salts	18	3 60
In nitrates	17½	3 50
Organic in—		
Blood	21	4 20
Mixed fertilizers	20	4 00
Fine* bone and tankage	20½	4 10
Medium* bone and tankage	16	3 20
Potash.		
From Sulfate	6	1 20
From Muriate	5	1 00

*Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas phosphate powder by a 100-mesh sieve.

REPORT OF ANALYSES.*

Available phosphoric acid is not determined in bone meal, tankage, and Thomas phosphate powder, unless requested. The fineness of these materials is determined, fine and medium bone being separated by a sieve of 50 meshes to the inch; tankage by a 25-mesh sieve; and Thomas phosphate powder by a 100-mesh sieve.

Nitrogen in ammonia salts will, in some cases, be found reported when nitrogen in this form is not guaranteed. In some of such cases this form of nitrogen is produced by conversion of organic nitrogen during process of manufacture, and is not to be considered a deviation from guaranty of materials used. Guanos carry more or less nitrogen in nitrates and ammonia salts, and when any appreciable quantity of guano is used the manufacturer should take into account the fact that some nitrogen will show as nitrates and ammonia salts. The failure to take this into consideration may perhaps account for the appearance of these forms of nitrogen in some samples in which only organic nitrogen was guaranteed.

The percentage of chlorin is given when it exceeds 0.50 per cent. It is a matter of only technical interest whether chlorin present is from muriate of potash, kainit, or from common salt that may be in some of the materials used. If a manufacturer uses sulfate of potash and uses a tankage with it containing a large amount of chlorin, from a practical standpoint he has lowered the grade of his fertilizer just as much as if he had used muriate of potash instead of sulfate of potash. Chlorin from all other sources is as objectionable as from muriate of potash. However, if muriate of potash is found when sulfate is guaranteed, the fact will be published.

The following abbreviations are used in the tables: Bl=blood, Bn=bone; Fs=fish; G=guano; Super=superphosphate; T=tankage.

Guaranties are entered in *italics*. Deficiencies greater than allowed by law are entered in bold type.

* The laboratory work in connection with these analyses was largely carried out by Mr. P. L. McCreary, to whom credit is due for his careful and conscientious work.

ANALYSES AND VALUATIONS.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Agricultural Chemical Works, Los Angeles, Cal.		
1219	Bat Guano and Gypsum	J. W. Cruickshank, Riverside	44.70
	Guaranteed		*45.20*
1455	Bat Guano and Bone	D. B. Bailey, Rialto	42.16
	Guaranteed		*39.40*
1250	Blood	G. A. Herdeg, Riverside	55.86
1287	do	Upland Feed and Fuel Co., Upland	**55.10**
1319	do	E. A. Moore, Redlands	56.20
	Guaranteed		*56.70*
1288*	Bone Flower	Upland Feed and Fuel Co., Upland	34.86
	Guaranteed		*26.38*
1363*	Bone Meal	Corona Lemon Co., Corona	30.77
1364*	do	do	31.70
	Guaranteed		*27.40*
1401*	Bone Meal	A. C. Pickett, Riverside	31.61
	Guaranteed		*27.38*
1253*	Fine Ground Bone	G. A Herdeg, Riverside	29.16
	Guaranteed		*26.50*
1266*	Fine Ground Bone	A. Cornelius, E. Highland	31.42
	Guaranteed		*29.27*
1362	Lawn	Ross Seed Store, Pasadena	22.87
1407	do	W. J. Rogers, Pomona	21.67
	Guaranteed		*21.00*
1318	Nitrate of Soda	E. A. Moore, Redlands	56.32
1460	do	do	54.63
	Guaranteed		*54.25*
1355	Potato	E. A. Moore, Redlands	27.91
	Guaranteed		*29.60*
1261	Special	A. Cornelius, E. Highland	26.69
	Guaranteed		*27.40*
1408	Special	W. J. Rogers, Pomona	24.81
	Guaranteed		*23.40*
1211	Special Orange and Lemon	G. A. Herdeg, Riverside	25.74
1217	do	J. W. Cruickshank, Riverside	26.42
1251	do	G. A. Herdeg, Riverside	25.22
	Guaranteed		*26.60*
1252	Special Orange and Lemon	G. A. Herdeg, Riverside	26.99
	Guaranteed		*28.45*
1218	Special Orange and Lemon	J. W. Cruickshank, Riverside	27.89
1351	do	G. A. Herdeg, Riverside	26.68
	Guaranteed		*25.70*
1361	Special Orange and Lemon	E. A. Moore, Redlands	26.42
	Guaranteed		*24.50*
1359	Special Orange and Lemon	E. A. Moore, Redlands	24.93
	Guaranteed		*24.30*
1354	Special Orange and Lemon	E. A. Moore, Redlands	26.44
	Guaranteed		*26.50*
1290	Special Orange and Lemon	Upland Feed and Fuel Co., Upland	25.33
1357	do	E. A. Moore, Redlands	24.60
	Guaranteed		*23.40*
1356	Special Orange and Lemon	E. A. Moore, Redlands	32.81
	Guaranteed		*34.18*
1291	Special Orange and Lemon	Upland Feed and Fuel Co., Upland	26.49
1360	do	E. A. Moore, Redlands	25.19
	Guaranteed		*27.10*

*1288—81 per cent fine. *1364—43 per cent fine. *1253—32 per cent fine.
*1363—42 per cent fine. *1401—55 per cent fine. *1266—58 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
1219			5.1				9.84		9.84		1.05		
			5.0				*10.00*		*10.00*		*1.00*		
1455	7.18	5.73	12.91		3.14	1.52	3.10	Bn, G	7.76			1.51	
	6.00	*6.00*	*12.00*						*7.00*			*1.00*	
1250							13.30		13.30				
1287							13.12		**13.12**				
1319							13.38		13.38				
							13.50		*13.50*				
1288	19.68	11.36	31.04				1.39		1.39				
	16.20	*4.60*	*20.80*				*1.16*		*1.16*				
1363			27.52				2.43		2.43				
1364			29.28				2.30		2.30				
			23.00				*2.50*		*2.50*				
1401			29.42				2.16		2.16				
			23.00				*2.40*		*2.40*				
1253			19.42				3.89		3.89				
			20.00				*3.00*		*3.00*				
1266	11.76	18.04	29.80				2.24		2.24				
	10.00	*19.00*	*29.00*				*2.10*		*2.10*				
1262	**3.29**	7.36	10.65				3.09		3.09	2.88			1.60
1407	4.24	6.80	11.04				2.92		2.92	**1.50**			1.18
	5.00	*5.00*	*10.00*	Super T			*2.50*	Bl, Bn	*2.50*	*2.50*			
1318					16.09				16.09				
1460					15.61				15.61				
					15.50				*15.50*				
1355	**4.45**	4.76	9.21				3.08		3.08		6.56		
	6.00	*4.00*	*10.00*	Super T			*3.00*	Bl, Bn	*3.00*		*7.00*		
1261	5.07	5.46	10.53		1.17		2.76		3.93		2.06		
	6.00	*4.00*	*10.00*	Super T	*1.00*		*3.00*		*4.00*		*2.00*		
1408	**5.73**	7.36	13.09				1.88		1.88		5.61		
	7.00	*6.00*	*13.00*	Super T			*1.50*	Bl, Bn	*1.50*		*5.00*		
1211	5.05	3.73	8.78		1.21		2.83		4.04		2.30		
1217	5.47	4.45	9.92		2.17	0.24	1.64		4.05		2.18		
1251	5.04	3.41	8.45		1.10	0.30	2.60		4.00		1.78		
	6.00	*3.00*	*9.00*	Super T	*1.00*		*3.00*	Bl, Bn	*4.00*		*2.00*		
1252	3.56	4.95	8.51		2.58	0.35	1.83		4.76		2.19		
	4.00	*4.00*	*8.00*	Super T	*1.50*		*3.50*	Bat G, Bl, Bn	*5.00*		*2.00*		
1218	5.63	4.61	10.24				3.03		3.03		5.59		
1351	5.00	6.28	11.28				2.68		2.68		5.68		
	5.00	*5.00*	*10.00*	Super T			*2.50*	Bl, Bn	*2.50*		*6.00*		
1361	7.05	3.37	10.42				1.16		1.16		9.69		0.56
	5.00	*5.00*	*10.00*	SuperT			*1.00*	Bl, Bn	*1.00*		*10.00*		
1359	**4.83**	6.81	11.64		1.22		2.03		3.25		2.78		
	6.00	*4.00*	*10.00*	Super T	*1.00*		*2.00*	Bat G, Bl, Bn	*3.00*		*3.00*		
1354	4.49	5.97	10.46				1.66		1.66		9.52		
	5.00	*5.00*	*10.00*	Super T			*1.50*	Bl, Bn	*1.50*		*10.00*		
1290	6.11	7.74	13.85				1.95		1.95		5.27		0.50
1357	**5.74**	8.22	13.96				1.90		1.90		5.00		
	7.00	*6.00*	*13.00*	Super T			*1.50*	Bl, Bn	*1.50*		*5.00*		
1356	5.37	4.52	9.89		0.99		2.76		3.75		8.00		
	6.00	*4.00*	*10.00*	Super T	*1.25*		*2.75*	Bl, Bn	*4.00*		*8.00*		
1291	5.20	6.28	11.48		1.23	0.13	2.40		3.76		2.28		
1360	**3.98**	6.23	10.21		1.09	0.41	2.45		3.95		1.83		
	6.00	*4.00*	*10.00*	Super T	*1.00*		*3.00*	Bl, Bn	*4.00*		*2.00*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Agricultural Chemical Works, Los Angeles, Cal.—Continued.		
1289	Special Orange and Lemon	Upland Feed and Fuel Co., Upland	24.23
1353	do	E. A. Moore, Redlands	24.86
1358	do	do	23.42
	Guaranteed		*23.60*
1352	Sulfate of Potash	E. A. Moore, Redlands	58.37
	Guaranteed		*57.60*
1257*	Tankage	A. Cornelius, E. Highland	29.28
	Guaranteed		*27.77*
1292*	Tankage	Upland Feed & Fuel Co., Upland	27.15
1350*	do	E. A. Moore, Redlands	27.02
	Guaranteed		*27.35*
1342*	Tankage	J. A. O'Kelly, Redlands	38.66
	Guaranteed		*36.05*
1409*	Tankage	W. J. Rogers, Pomona	27.24
	Guaranteed		*28.57*
1457*	Tankage	C. H. Clock, Redlands	37.10
	Guaranteed		*36.80*
1458*	Tankage	J. N. Clark, Redlands	**33.95**
	Guaranteed		*36.28*
1459*	Tankage	C. L. Clock, Redlands	35.41
	Guaranteed		*36.02*
1463*	Tankage	E. A. Moore, Redlands	31.34
	Guaranteed		*31.99*
	American Agricultural Chemical Co., Los Angeles, Cal.		
1349	Lawn	Johnson, Musser Seed Co., Los Angeles	30.16
	Guaranteed		*28.27*
1255	Nursery Stock	Graham, Cope Com.'l Co., Redlands	29.27
	Guaranteed		*28.19*
1256	Nursery Stock	R. S. Thompson, Highland	29.89
1293	do	J. F. Monro, Upland	29.79
1437	do	W. A. Johnstone, San Dimas	28.98
1445	do	H. H. Hills, San Fernando	29.53
	Guaranteed		*28.28*
1259	Orange and Lemon	Graham, Cope Com.'l Co., Redlands	28.26
1294	do	J. F. Monro, Upland	27.84
1343	do	S. H. Barrett, E. Highland	28.73
1438	do	W. A. Johnstone, San Dimas	27.95
	Guaranteed		*27.47*
	Armour Fertilizer Works, Los Angeles, Cal.		
1366	Blood	R. T. Murrell, Pomona	54.81
	Guaranteed		*52.50*
1367	Blood	R. T. Murrell, Pomona	57.75
	Guaranteed		*58.80*
1229	Blood, Bone, and Potash	I. W. Freeman, Redlands	34.40
1376	do	Factory, Colton	33.75
1411	do	A. M. Seeley, Covina	37.46
	Guaranteed		*34.40*
1269	Blood, Bone, and Potash	G. W. Russell, Ontario	37.89
1317	do	H. L. Hostetler, Covina	37.13
	Guaranteed		*34.00*

*1257—76 per cent fine. *1342—70 per cent fine. *1458—81 per cent fine.
*1292—72 per cent fine. *1409—73 per cent fine. *1459—76 per cent fine.
*1350—71 per cent fine. *1457—89 per cent fine. *1463—85 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
1289	5.21	5.98	11.19				3.10		3.10		2.16		
1353	**4.67**	7.06	11.73				3.34		3.34		1.97		
1358	**3.60**	8.23	11.83				3.09		3.09		2.18		
---	*6.00*	*4.00*	*10.00*	Super T			*3.00*	Bl, Bn	*3.00*		*2.00*		
1352											48.64		
---											*48.00*		
1257			18.32				3.75		**3.75**				
---			*14.00*	Bn			*4.25*	Bl, Bn	*4.25*				
1292			13.28				4.35		4.35				
1350			13.82				4.20		4.20				
---			*14.00*	Bn			*4.25*	Bl, Bn	*4.25*				
1342			12.38				7.57		7.57				
---			*13.00*	Bn			*6.75*	Bl, Bn	*6.75*				
1409			13.30				4.30		4.30				
---			*14.00*	Bn			*4.25*	Bl, Bn	*4.25*				
1457			15.13				6.25		6.25				
---			*13.50*	Bn			*6.50*	Bl, Bn	*6.50*				
1458			**11.37**				6.34		6.34				
---			*13.50*	Bn			*6.50*	Bl, Bn	*6.50*				
1459			**12.25**				6.60		6.60				
---			*13.50*	Bn			*6.50*	Bl, Bn	*6.50*				
1463			**12.20**				5.45		5.45				
---			*13.50*	Bn			*5.35*	Bl, Bn	*5.35*				
1349	9.87	1.28	11.15	All samples of complete fertilizer of this company, Bn, Super.	2.60	1.00	0.67	All samples of complete fertilizer of this company, Bl, Bn, Bat G, T	4.27		1.91		
---	*9.00*	*1.00*	*10.00*		*1.65*	*1.00*	*1.45*		*4.10*		*1.50*		
1255	8.99	1.43	10.42		2.81	0.51	1.00		4.32		1.74		
---	*9.00*	*1.00*	*10.00*		*2.30*	*0.40*	*1.40*		*4.10*		*1.50*		
1256	8.71	3.41	12.12		2.69	0.94	0.70		4.33		1.78		
1293	8.94	3.23	12.17		2.51	0.92	0.80		4.23		1.79		
1437	9.24	1.57	10.81		2.70	0.81	0.65		4.16		1.78		
1445	9.20	1.81	11.01		2.36	1.18	0.69		4.23		1.93		
---	*9.00*	*1.00*	*10.00*		*1.65*	*1.00*	*1.45*		*4.10*		*1.50*		
1259	8.45	1.12	9.57		2.53	0.50	0.70		3.73		3.36		0 50
1294	8.29	1.51	9.80		2.61	0.54	0.70		3.85		2.72		0.54
1343	8.45	1.11	9.56		2.61	0.56	0.61		3.78		3.65		0.50
1438	8.46	1.38	9.84		2.47	0.55	0.68		3.70		3.13		
---	*8.00*	*1.00*	*9.00*		*2.00*	*0.40*	*1.30*		*3.70*		*3.00*		
1366							13.05		13.05				
---							*12.50*		*12.50*				
1367							13.75		13.75				
---							*14.00*		*14.00*				
1229	8.11	2.14	10.25			1.02	2.79		3.81		7.31		0 70
1376	9.88	1.57	11.45			0.94	2.63		**3.57**		**6.00**		0.56
1411	8.70	1.29	9.99	Bn, G, Super		1.49	2.85		4.34		7.77		
---	*8.00*	*2.00*	*10.00*			*1.50*	*2.50*	Bl, Bn, G, T	*4.00*		*7.00*		
1269	8.09	2.55	10.64		2.55	0.12	2.13		4.80		7.53		
1317	8.35	1.95	10.30		2.00	0.10	2.12		4.22		8.58		
---	*8.00*	*2.00*	*10.00*	Bn, G, per	*2.00*		*2.00*	Bl, Bn, G, T	*4.00*		*7.00*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Armour Fertilizer Works, Los Angeles, Cal.—Continued.		
1236*	Bone Floats	I. W. Freeman, Redlands	**27.55**
	Guaranteed		*29.90*
1396*	Bone Floats	J. Schermerhorn, Colton	**26.98**
	Guaranteed		*28.80*
1235*	Bone Meal	I. W. Freeman, Redlands	30.52
	Guaranteed		*29.30*
1268*	Bone Meal	G. W. Russell, Ontario	31.74
	Guaranteed		*28.40*
1368*	Bone Meal	R. T. Murrell, Pomona	31.55
	Guaranteed		*28.08*
1338*	Bone Meal	Mrs. M. A. Fox, Colton	29.94
1369*	do	R. T. Murrell, Pomona	33.59
	Guaranteed		*27.35*
1371*	Bone Meal	John Blake, Pasadena	29.78
	Guaranteed		*27.10*
1372*	Bone Meal	Factory, Colton	29.33
	Guaranteed		*27.15*
1374	Fruit Special	R. T. Murrell, Pomona	21.91
	Guaranteed		*22.40*
1226	Fruit and Vine	I. W. Freeman, Redlands	29.78
	Guaranteed		*27.70*
1412	Fruit and Vine	A. M. Seeley, Covina	30.71
	Guaranteed		*27.90*
1370	Lawn and Garden	John Blake, Pasadena	26.04
	Guaranteed		*25.35*
1230	Nitrate of Soda	I. W. Freeman, Redlands	52.99
	Guaranteed		*52.50*
1216	Orange Tree Manure	J. W. Cruickshank, Riverside	30.52
1228	do	I. W. Freeman, Redlands	27.60
1295	do	G. W. Russell, Ontario	29.61
1373	do	R. T. Murrell, Pomona	29.07
1378	do	J. C. Boyd, Rialto	27.39
1413	do	A. M. Seeley, Covina	29.90
1436	do	Santiago O. G. Association, Orange	28.89
	Guaranteed		*26.80*
1225	Pea Special	I. W. Freeman, Redlands	24.04
1377	do	Factory, Colton	**18.39**
1394	do	Tom West, San Diego	19.91
	Guaranteed		*22.00*
1314	Special	O. H. Hicks, Redlands	35.83
	Guaranteed		*30.20*
1322	Special	Margaret Seeley, Covina	39.46
	Guaranteed		*38.80*
1270	Special 5-8-2	G. W. Russell, Ontario	29.92
	Guaranteed		*28.50*
1227	Special 5-8-2	I. W. Freeman, Redlands	27.58
1296	do	G. W. Russell, Ontario	29.16
	Guaranteed		*28.00*
1224	Special 5-8-2	I. W. Freeman, Redlands	30.93
1379	do	R. T. Murrell, Pomona	30.49
1380	do	E. Highland O. Co., E. Highland	32.44
1414	do	A. M. Seeley, Covina	28.18
1434	do	D. B. Williams, San Diego	29.69
	Guaranteed		*28.40*

*1236—96 per cent fine. *1268—60 per cent fine. *1369—75 per cent fine.
*1396—97 per cent fine. *1368—49 per cent fine. *1371—67 per cent fine.
*1235—75 per cent fine. *1338—74 per cent fine. *1372—69 per cent fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	POUNDS PER HUNDRED.												
	PHOSPHORIC ACID.				NITROGEN.					POTASH.			Chlorin
	Available	Insoluble	Total	Guaranteed as Derived From	In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	From Muriate	From Sulfate	Total	
1236			24.50				1.94		**1.94**				
			22.00				*3.00*		*3.00*				
1396			**23.82**				1.98		1.98				
			26.00				*2.00*		*2.00*				
1235			25.48				2.60		**2.60**				
			22.00				*3.00*		*3.00*				
1268			31.84				1.65		**1.65**				
			26.00				*2.00*		*2.00*				
1368			32.16				1.60		**1.60**				
			26.00				*2.00*		*2.00*				
1338			23.64				2.83		2.83				
1369			27.08				3.06		3.06				
			22.00				*2.50*		*2.50*				
1371			23.64				2.86		2.86				
			22.00				*2.50*		*2.50*				
1372			23.86				2.68		2.68				
			22.00				*2.50*		*2.50*				
1374	8.51	2.73	11.24	Bn, G, Super		0.35	1.10		1.45		**3.89**		
	8.00	*2.00*	*10.00*			*0.50*	*1.00*	Bn, G	*1.50*		*5.00*		
1226	7.20	1.4	8.68	Bn, G, Sup	0.90		1.22		2.12		10.31		0.58
	6.00	*2.00*	*8.00*		*1.00*		*1.00*	Bl, Bn, G, T	*2.00*		*10.00*		
1412	7.63	1.72	9.35	Bn, G, Super		0.92	1.22		2.14		10.30		0 62
	6.00	*2.00*	*8.00*			*1.00*	*1.00*	Bl, Bn, G, T	*2.00*		*10.00*		
1370	4.35	1.81	6.16	Bn, G, Super	1.51		2.50		4.01		3.82		
	4.00	*1.00*	*5.00*		*1.50*		*2.50*	Bn, G,	*4.00*		*4.00*		
1230					15.14				15.14				
					15.00				*15.00*				
1216	9.49	1.15	10.64			1.47	2.21		3.68		3.69		
1228	8.57	2.79	11.36			1.10	1.90		3.00		3.63		
1295	9.85	1.43	11.28			1.10	2.08		3.18		3.99		
1373	8.42	2.44	10.86			1.39	1.75		3.14		4.79		
1378	8.81	2.37	11.18			1.10	1.77		2.87		3.82		
1413	9.53	1.70	11.23			1.19	1.85		3.04		4.94		
1436	8.66	1.66	10.32	Bn, G, Super		1.25	2.07		3.32		4.07		
	8.00	*2.00*	*10.00*			*1.50*	*1.50*	Bl, Bn, G, T	*3.00*		*4.00*		
1225	5.37	9.61	14.98				1.79		1.79		4.69		0.64
1377	**3.29**	8.65	11.94				1.38		**1.38**		3.83		0.78
1394	**3.12**	9.30	12.42	Bn, G, Super			1.52		1.52		4.53		
	6.00	*6.00*	*12.00*				*1.75*	Bl, Bn, G, T	*1.75*		*4.00*		
1314			22.22				2.80		2.80		5.71		
			19.00	Bn			*2.20*	Bn	*2.20*		*5.00*		
1322			14.58				6.95		**6.95**				
			11.00	Bn			*7.50*	Bl, Bn	*7.50*				
1270	8.93	1.28	10.21	Bn, G, Super	1.44	0.13	2.45		4.02		2.71		
	8.00	*2.00*	*10.00*		*1.00*		*3.00*	Bl, Bn, G, T	*4.00*		*2.00*		
1227	7.77	2.69	10.46		1.86		1.89		3.75		2.36		
1296	7.73	2.68	10.41	Bn, G, Super	1.83	0.10	2.25		4.18		2.32		
	8.00	*2.00*	*10.00*		*2.00*		*2.00*	Bl, Bn, G, T	*4.00*		*2.00*		
1224	8.72	2.50	11.22			1.40	2.71		4.11		2.78		
1379	8.78	1.63	10.41			1.39	2.80		4.19		2.45		
1380	9.22	1.59	10.81			1.55	3.00		4.55		2.50		
1414	8.32	1.72	10.04			1.02	2.75		3.77		2.21		
1434	11.54	1.56	13.10	Bn, G, Super	0.21	1.31	1.70		**3.22**		2.34		
	8.00	*2.00*	*10.00*			*1.50*	*2.50*	Bl, Bn, G, T	*4.00*		*2.00*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Armour Fertilizer Co., Los Angeles, Cal.—Continued.		
1375	Special 6½-12-6	Factory, Colton	**39.25**
	Guaranteed		*42.80*
1233	Sulfate of Potash	I. W. Freeman, Redlands	57.31
	Guaranteed		*57.60*
1231*	Tankage	I. W. Freeman, Redlands	**28.85**
	Guaranteed		*31.50*
1237*	Tankage	Arlington Heights Ft. Co., Riverside	31.34
1246*	do	do	29.73
1247*	do	do	30.12
1248*	do	do	31.03
1249*	do	do	30.06
	Guaranteed		*29.40*
1267*	Tankage	G. W. Russell, Ontario	28.55
	Guaranteed		*29.90*
	Balfour, Guthrie & Co., San Fran., Cal.		
1446	Nitrate of Soda	J. B. Lungaier, Los Angeles	56.00
	Guaranteed		*52.50*
	California Fertilizer Works, San Francisco, Cal.		
1271*	Bone Meal	Haight, Bethell Co., Redlands	32.23
	Guaranteed		*30.30*
1209	Special	W. P. Hammon, Palermo	29.53
	Guaranteed		*28.30*
1215	Special	E. E. Potter, San Francisco	36.00
	Guaranteed		*32 00*
1272	Special Orange and Lemon	Haight, Bethell Co., Redlands	27.34
	Guaranteed		*27.53*
	Cudahy Packing Company, South Omaha, Neb.		
1439	Blood and Bone	Pattee & Lett Co., Riverside	**30.38**
	Guaranteed		*35.40*
	Mapes Formula and P. G. Co., N. Y.		
1273	Mapes Orange Tree Manure	J. J. Prendergast, Redlands	26.36
	Guaranteed		*23.70*
	Morris & Co., Chicago.		
1404*	Pacific Big Two	Colton Hardware Co., Colton	**30.28**
	Guaranteed		*43.20*
1405*	Pacific Big Two	S. Ross, Fullerton	**30.13**
	Guaranteed		*43.15*
1406*	Pacific Big Two	P. D. Durkee, San Dimas	**31.48**
	Guaranteed		*43.25*
1447*	Pacific Big Two	J. F. Jackson, Riverside	**29.49**
	Guaranteed		*42.95*
1262	Big Eight—Bone and Potash	Haight, Bethell Co., Redlands	35.91
	Guaranteed		*31.40*
1264*	Tankage	Haight, Bethell Co., Redlands	42.32
	Guaranteed		*42.80*
1265	Blood	Haight, Bethell Co., Redlands	55.94
	Guaranteed		*54.60*

*1231—76 per cent fine.
*1237—71 per cent fine.
*1246—71 per cent fine.
*1247—70 per cent fine.
*1248—64 per cent fine.
*1249—73 per cent fine.
*1267—80 per cent fine.
*1271—60 per cent fine.
*1404—71 per cent fine.
*1405—68 per cent fine.
*1406—74 per cent fine.
*1447—61 per cent fine.
*1264—83 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
1375			14.42				5.23		**5.23**		5.66		
			12.00	Bn			*6.50*	Bl, Bn	*6.50*		*6.00*		
1233											47.76		1.14
											48.00		
1231			**10.51**				5.24		5.24				
			15.00	Bn			*5.00*	Bl, Bn	*5.00*				
1237			**11.20**				5.89		5.89				
1246			12.04				5.29		5.29				
1247			12.24				5.35		5.35				
1248			12.42				5.55		5.55				
1249			12.50				5.28		5.28				
			13.00	Bn			*5.00*	Bl, Bn	*5.00*				
1267			12.14				4.83		4.83				
			13.00	Bn			*5.00*	Bl, Bn	*5.00*				
1446					16.00				16.00				
					15.00				*15.00*				
1271			27.08				2.78		2.78				
			26.00				*2.50*		*2.50*				
1209	9.73	6.03	15.76				3.71		**3.71**				
	9.00	*3.00*	*12.00*	Bn, Super			*4.00*	Bl, Bn	*4.00*				
1215			15.06		1.43	0.40	4.16		5.99				
			13.00	Bn			*5.40*	Bl, Bn	*5.40*				
1272	7.00	4.57	11.57		0 67	0.25	1.84		2.76		5.04		0.62
	7.00	*2.50*	*9.50*	Bn, Super	*0.25*		*2.75*	Bl, Bn	*3.00*		*5.00*		
1439	**4.69**	7.02	11.71				5.31		5.31				
	7.50	*6.00*	*13.50*	Bn			*5.35*	Bl, Bn	*5.35*				
1273	5.99	4.63	10.62		2.46	0.31	0.83		3.60		3.17		0.76
	6.00	*2.00*	*8.00*	Bn, G	*2.40*	*0.15*	*0.74*	G	*3.29*		*3.00*		
1404	**10.19**	19.97	30.16				2.10		**2.10**				
	28.00	*0.00*	*28.00*	Bn			*2.50*	Bn	*2.50*				
1405	**9.40**	19.98	29.38				2.32		2.32				
	28.00	*0.00*	*28.00*	Bn			*2.50*	Bn	*2.50*				
1406	**11.16**	18.72	29.88				2.26		2.26				
	28.00	*0.00*	*28.00*	Bn			*2.50*	Bn	*2.50*				
1447	**11.46**	18.68	30.14				1.71		**1.71**				
	28.00	*0.00*	*28.00*	Bn			*2.50*	Bn	*2.50*				
1262			27.30				2.35		2.35		3.69		
			23.00				*2.00*		*2.00*		*4.00*		
1264			5.33				9.66		9.66				
			5.50	Bn			*9.75*	Bl, Bn	*9.75*				
1265							13.32		13.32				
							13.00		*13.00*				

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Mountain Copper Company, San Francisco, Cal.		
1238	Mixed Fertilizer	Sparr Fruit Co., Riverside	32.94
	Guaranteed		*31.71*
1239	Mixed Fertilizer	Sparr Fruit Co., Riverside	25.77
	Guaranteed		*24.50*
1279	Superphosphate	Arlington Heights Ft. Co., Riverside	25.42
1280	do	do	24.94
1281	do	do	25.61
1282	do	do	25.21
1283	do	do	25.13
1284	do	do	25.78
1303	do	do	24.77
1304	do	do	24.53
1305	do	do	24.98
1306	do	do	25.33
1307	do	do	25.55
1308	do	do	25.10
1309	do	do	25.51
1310	do	do	25.54
1311	do	do	25.80
1312	do	do	25.61
1313	do	do	24.92
1327	do	do	24.83
1328	do	do	24.88
1329	do	do	24.85
1330	do	do	25.32
1331	do	do	25.02
1332	do	do	25.54
1333	do	do	25.22
1334	do	do	25.03
1335	do	do	24.05
1336	do	do	24.95
1348	do	do	25.99
1397	do	do	23.94
1398	do	do	25.28
	Sold on Station analysis.		
1232	Superphosphate Medium	J. W. Cruickshank, Riverside	22.79
1337	do	Redlands Fruit Associa'n, Redlands	22.67
1326	do	C. E. Davis, Redlands	23.22
	Guaranteed		*22.62*
1433	Superphosphate Medium	F. M. Chapman, Covina	22.92
	Guaranteed		*22.04*
	Pacific Guano and Fert. Co., San Francisco, Cal.		
1444	Fruit and Vine	C. A. Tripp, Redlands	30.97
	Guaranteed		*30.63*
1345	Fruit and Vine	George S. Gay, Craftonville	31.24
1347*	do	W. H. Bicknell, Redlands	31.50
1382*	do	H. C. Rumohr, Redlands	31.53
1440*	do	H. C. Norris, San Dimas	30.04
	Guaranteed		*30.22*
1346*	Nursery Stock	W. H. Bicknell, Redlands	30.34
1381*	do	H. C. Rumohr, Redlands	30.62
	Guaranteed		*29.10*
1441*	Special Fruit and Vine	H. C. Norris, San Dimas	30.64
	Guaranteed		*29.00*

*Shrimp Shells.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	Phosphoric Acid. Available	Insoluble	Total	Guaranteed as Derived From	Nitrogen. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	Potash. From Muriate	From Sulfate	Total	Chlorin
1238	10.86	0.33	11.19	.....	2.80	.....	1.20	.....	4.00	.....	4.28	.....	.....
----	*10.00*	*0.50*	*10.50*	Super	*2.67*	.....	*1.33*	Bl, Bn	*4.00*	.....	*4.00*	.....	.....
1239	13.18	1.21	14.39	.....	.....	.....	.....	.....	.....	.....	7.79	.....	.....
----	*12.00*	*1.00*	*13.00*	Super	.....	.....	.....	.....	.....	.....	*8.00*	.....	.....
1279	21.18	0.26	21.44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1280	20.78	0.24	21.02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1281	21.34	0.22	21.56	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1282	21.01	0.23	21.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1283	20.94	0.22	21.16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1284	21.48	0.22	21.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1303	20.64	0.28	20.92	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1304	20.44	0.26	20.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1305	20.82	0.26	21.08	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1306	21.11	0.19	21.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1307	21.29	0.23	21.52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1308	20.92	0.24	21.16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1309	21.26	0.22	21.48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1310	21.28	0.20	21.48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1311	21.50	0.24	21.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1312	21.34	0.24	21.58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1313	20.77	0.23	21.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1327	20.69	0.29	20.98	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1328	20.73	0.27	21.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1329	20.71	0.29	21.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1330	21.10	0.36	21.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1331	20.85	0.27	21.12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1332	21.28	0.36	21.64	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1333	21.02	0.56	21.58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1334	20.86	0.42	21.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1335	20.04	0.60	20.64	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1336	20.79	0.51	21.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1348	21.66	0.32	21.98	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1397	19.95	0.79	20.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1398	21.07	0.51	21.58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1232	18.99	0.33	19.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1337	18.89	0.51	19.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1326	19.35	0.47	19.82	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
----	*18.85*	*0.75*	*19.60*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1433	19.10	0.42	19.52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
----	*18.37*	*0.70*	*19.07*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1444	8.00	3.70	11.70	Bn, Super	1.04	0.15	1.65	.....	2.84	.....	7.28	.....	0.96
--	*8.00*	*2.50*	*10.50*		*0.85*	.....	*2.10*	Bl, Bn	*2.95*	.....	*7.00*	.....	.....
1345	8.23	4.61	12.84	.....	1.38	0.15	1.40	.....	2.93	.....	6.74	.....	.....
1347	8.75	3.01	11.76	.....	0.57	0.20	1.59	.....	**2.36**	.....	8.45	.....	†1.00
1382	8.43	3.27	11.70	.....	0.97	0.15	1.80	.....	2.92	.....	6.82	.....	†1.12
1440	7.76	3.62	11.38	.....	0.94	0.10	1.75	.....	2.79	.....	6.89	.....	†1.24
----	*8.00*	*2.50*	*10.50*	Super	*0.85*	.....	*2.00*	Bl, Bn	*2.85*	.....	*7.00*	.....	.....
1346	9.41	1.38	10.79	.....	1.21	0.26	2.50	.....	3.97	.....	2.66	.....	†2.00
1381	8.85	1.37	10.22	.....	1.29	0.19	2.70	.....	4.18	.....	2.77	.....	†2.14
----	*9.00*	.....	.....	Bn, Super	*1.00*	.....	*3.10*	Bl, Bn, Fs	*4.10*	.....	*2.00*	.....	.....
1441	7.95	3.76	11.71	.....	0.64	.....	2.01	.....	2.65	.....	7.45	.....	†1.28
----	*8.00*	*2.50*	*10.50*	Bn, Super	*0.50*	.....	*2.00*	Bl, Bn	*2.50*	.....	*7.00*	.....	.....

† Chlorin high.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Carroll B. Smith, Redlands.		
1189	Bat Guano	E. L. Koethen, Riverside	25.51
	Guaranteed		*26.73*
1240	Bat Guano	E. L. Koethen, Riverside	23.44
	Sold on Station analysis.		
1464	Bat Guano	Carroll B. Smith, Redlands	**21.22**
	Guaranteed		*25.78*
1465	Bat Guano	Carroll B. Smith, Redlands	**22.02**
	Guaranteed		*25.01*
1275*	Bone Meal	Carroll B. Smith, Redlands	30.98
	Guaranteed		*28.25*
1241	Special	Carroll B. Smith, Redlands	40.21
	Guaranteed		*38.40*
1274	Special	Carroll B. Smith, Redlands	41.25
	Guaranteed		*42.40*
1276*	Tankage	Carroll B. Smith, Redlands	31.43
	Guaranteed		*31.50*
	Swift & Co., Chicago.		
1385	Blood	E. L. Koethen, Riverside	57.04
	Guaranteed		*54.60*
1213*	Diamond "E"	O. H. Stanton, Cucamonga	33.90
1242*	do	C. B. Smith, Redlands	35.07
	Guaranteed		*34.46*
1384*	Diamond "E"	E. L. Koethen, Riverside	34.78
1410*	do	do	35.41
	Guaranteed		*34.37*
1212	Diamond "D"	O. H. Stanton, Cucamonga	36.37
	Guaranteed		*33.76*
1277	Diamond "G"	Carroll B. Smith, Redlands	35.23
	Guaranteed		*34.20*
1278	Special Acidulated Bone Meal	Carroll B. Smith, Redlands	27.37
	Guaranteed		*25.89*
1383*	Special Bone Meal	E. L. Koethen, Riverside	30.89
	Guaranteed		*26.25*
	Union Fertilizer Company, Los Angeles.		
1321	Blood	J. F. Jackson, Riverside	49.56
1415	do	G. R. Tyler, Lordsburg	50.82
1416	do	J. F. Jackson, Riverside	50.69
	Guaranteed		*50.40*
1297*	Bone Meal	I. W. Freeman, Upland	30.78
	Guaranteed		*28.75*
1388*	Bone Meal	E E. Cole, Redlands	33.79
	Guaranteed		*33.88*
1420*	Bone Meal	Thos. Strain, Jr., Fullerton	29.43
	Guaranteed		*24.80*
1365*	Bone Meal	W. A. Hively, Corona	31.21
	Guaranteed		*27.88*

*1275—29 per cent fine.
*1276—73 per cent fine.
*1213—74 per cent fine.
*1242—73 per cent fine.
*1384—75 per cent fine.
*1410—75 per cent fine.
*1383—58 per cent fine.
*1297—32 per cent fine.
*1388—67 per cent fine.
*1420—42 per cent fine.
*1365—71 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
1189			10.82						**4.53**			0.45	
			9.87						*5.11*			*0.37*	
1240			11.32						3.47			0.42	
1464			8.48						**3.54**			0.23	
			8.49						*4.57*			*0.59*	
1465			**7.58**						**3.89**			0.33	
			9.51						*4.22*			*0.43*	
1275			21.44				3.95		3.95				
			20.00				*3.50*		*3.50*				
1241			17.14				4.36		4.36		7.63		
			16.25	Bn			*4.25*	Bl, Bn	*4.25*		7.00		
1274			12.10				4.79		4.79		10.34		0 60
			13.00	Bn			*5.00*	Bl, Bn	*5.00*		*10.00*		
1276			15.94				4.79		4.79				
			15.00	Bn			*5.00*	Bl, Bn	*5.00*				
1385							13.58		13.58				
							13.00		*13.00*				
1213			20.00				4.59		**4.59**				
1242			19.46				5.00		5.00				
			19.00	Bn			*4.94*	Bl, Bn	*4.94*				
1384			20.74				4.69		**4.69**				
1410			19.42				5.12		5.12				
			19.00	Bn			*4.94*	Bl, Bn	*4.94*				
1212			20.32				1.82		1.82		10.69		
			19.00	Bn			*1.64*	Bl, Bn	*1.64*		*10.00*		
1277			21.16				2.90		**2.90**		5.58		1.22
			19.00	Bn			*3.25*	Bl, Bn, T	*3.25*		*5.00*		
1278	**15.62**	6.38	22.00	Bn,			1.36		1.36				
	18.00	*2.00*	*20.00*	Super			*0.82*	Bn	*0.82*				
1383			30.06				1.84		1.84				
			29.00				*0.82*		*0.82*				
1321							11.80		11.80				
1415							12.10		12.10				
1416							12.07		12.07				
							12.00		*12.00*				
1297			26.70				2.69		2.69				
			25.00				*2.50*		*2.50*				
1388			30.22				2.53		2.53				
			30.00				*2.60*		*2.60*				
1420			28.32				1.88		1.88				
			22.00				*2.00*		*2.00*				
1365			27.64				2.37		2.37				
			23.00				*2.47*		*2.47*				

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices
	Union Fertilizer Company, Los Angeles Cal.—Continued.		
1417*	Bone Meal	G. R. Tyler, Lordsburg	28.09
1418*	do	do	29.62
	Guaranteed		*27.44*
1419*	Bone Meal	J. F. Jackson, Riverside	30.23
	Guaranteed		*27.34*
1454*	Bone Meal	J. F. Jackson, Riverside	30.34
	Guaranteed		*27.29*
1243	Fruiting	E. E. Cole, Redlands	27.54
1254	do	C. A. Miller, Highland	26.58
1298	do	I. W. Freeman, Upland	25.59
1421	do	M. L. Mehnert, Covina	27.80
1422	do	J. F. Jackson, Riverside	26.21
1423	do	Geo. R. Tyler, Lordsburg	25.31
	Guaranteed		*24.13*
1320	Nitrate of Soda	J. F. Jackson, Riverside	55.44
1442	do	Arlington Heights Ft. Co., Riverside	53.48
	Guaranteed		*52.50*
1443	Nursery	Thos. Strain, Jr., Fullerton	29.78
	Guaranteed		*28.85*
1424	Pea	G. R. Tyler Lordsburg	22.80
1425	do	M. L. Mehnert, Covina	23.09
	Guaranteed		*21.20*
1387	Special	J. F. Jackson, Riverside	23.81
	Guaranteed		*21.30*
1426	Special	M. L. Mehnert, Covina	31.38
	Guaranteed		*29.60*
1427	Special	Geo. R. Tyler, Lordsburg	21.10
1428	do	do	21.46
	Guaranteed		*22.00*
1214	Sulfate of Potash	N. L. May, Rialto	60.00
1386	do	J. F. Jackson, Riverside	60.34
	Guaranteed		*60.00*
1399	Superphosphate	Arlington Heights Ft. Co., Riverside	25.14
1400	do	do	25.26
1402	do	do	24.71
	Sold on Station analysis.		
1244*	Tankage	E. E. Cole, Redlands	32.63
	Guaranteed		*32.69*
1245*	Tankage	E. E. Cole, Redlands	34.69
	Guaranteed		*34.92*
1389*	Tankage	J. F. Jackson, Riverside	31.96
	Guaranteed		*32.04*
1429*	Tankage	Thomas Strain, Jr., Fullerton	31.83
	Guaranteed		*31.93*
1430*	Tankage	G. R. Tyler, Lordsburg	31.40
	Guaranteed		*32.05*
1431*	Tankage	J. F. Jackson, Riverside	32.22
	Guaranteed		*33.20*
1432*	Tankage	J. F. Jackson, Riverside	35.99
	Guaranteed		36.44

*1417—43 per cent fine.
*1418—52 per cent fine.
*1419—46 per cent fine.
*1454—45 per cent fine.
*1244—74 per cent fine.
*1245—71 per cent fine.
*1389—51 per cent fine.
*1429—49 per cent fine.
*1430—50 per cent fine.
*1431—72 per cent fine.
*1432—77 per cent fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
1417			25.00				2.26		2.26				
1418			23.66				2.92		2.92				
			23.00				*2.47*		*2.47*				
1419			24.44				2.95		2.95				
			23.00				*2.47*		*2.47*				
1454			25.64				2.73		2.73				
			23.00				*2.47*		*2.47*				
1243	8.28	2.54	10.82		0.96	0.53	1.76		3.25		3.35		0.84
1254	7.97	2.05	10.02		1.00	0.43	1.70		3.13		3.45		
1298	7.98	0.73	8.71		1.44	0.66	1.35		3.45	2.82			4.98
1421	7.03	5.58	12.61		0.56	0.43	2.21		3.20		3.52		0.50
1422	7.35	5.18	12.53		0.56	0.54	1.99		3.09		**2.45**		0.80
1423	6.51	4.50	11.01	Bn, Super	0.58	0.40	1.97		2.95		3.25		†2.22
	7.00	*1.50*	*8.50*		*0.75*	*0.60*	*1.65*	Bn, G, T	*3.00*		*3.00*		
1320					15.84				15.84				
1442					15.28				15.28				
					15.00				*15.00*				
1443	5.72	2.27	7.99	Bn, Super	1.76	0.20	3.07		5.03		2.18		
	6.00	*1.50*	*7.50*		*1.00*	*1.00*	*3.00*	Bn, G, T	*5.00*		*1.50*		
1424			17.18						1.52		2.48		0.60
1425			17.94		0.07	0.51	0.83		1.41		2.80		0.62
			16.00				*1.50*		*1.50*		*2.00*		
1387	19.84	0.52	20.36										
	17.75			Super									
1426	10.42	2.08	12.50	Bn, Super					**1.49**		9.90		1.02
	8.00							Bn, G, T	*2.00*		*10.00*		
1427			21.48						**0.98**				
1428			21.98						**0.97**				
			21.00						*1.30*				
1214											50.00		
1386											50.28		1.56
											50.00		
1399	20.95	0.29	21.24										
1400	21.05	0.47	21.52										
1402	20.59	0.47	21.06										
1244			15.10				5.27		5.27				
			16.00	Bn			*5.10*	Bl, Bn	*5.10*				
1245			14.62				6.05		6.05				
			14.20	Bl			*6.20*	Bl, Bn	*6.20*				
1389			13.65				5.75		5 75				
			13.75	Bn			*5.75*	Bl, Bn	*5.75*				
1429			14.08				5.65		5.65				
			13.75	Bn			*5.75*	Bl, Bn	*5.75*				
1430			14.22				5.47		**5 47**				
			13.75	Bn			*5 75*	Bl, Bn	*5.75*				
1431			14.08				5.43		**5.43**				
			13.75	Bn			*5.75*	Bl, Bn	*5·75*				
1432			14.62				6.26		6.26				
			15.00	Bn			*6.30*	Bl, Bn	*6.30*				

† Chlorin high.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Woodbridge Chemical Works, San Bernardino, Cal.		
1299	Citrus A.	J. H. Reynolds, Redlands	30.36
	Guaranteed		*28.42*
1390	Citrus A.	J. H. Reynolds, Redlands	28.23
	Guaranteed		*29.13*
1263	Citrus B.	Factory	24.63
1300	do	J. H. Reynolds, Redlands	24.10
	Guaranteed		*22.80*
1448	† Citrus B.	Factory	22.99
1451	do	do	21.84
	Guaranteed		*22.10*
1391	Citrus B.	Factory	20.58
	Guaranteed		*22.50*
1395	Citrus B.	P. B. Fussel	**24.69**
	Guaranteed		*28.80*
1392	Citrus B. Special	Factory	22.76
	Guaranteed		*22.60*
1453	Citrus B. Special	Factory	26.45
	Guaranteed		*25.30*
1301	Nitrate of Soda	J. H. Reynolds, Redlands	55.51
	Guaranteed		*52.50*
1452	Nursery	Factory	**26.92**
	Guaranteed		*31.20*
1258	Orange and Lemon No. 1	Factory	31.27
	Guaranteed		*29.70*
1286	Orange and Lemon No. 1	W. T. Rodgers, Redlands	30.04
1393	do	Factory	32.28
	Guaranteed		*29.50*
1285	Special	W. T. Rodgers, Redlands	25.60
	Guaranteed		*22.20*
1302*	Tankage	J. H. Reynolds, Redlands	28.74
	Guaranteed		*28.30*
	Woodbridge Fertilizer Company, Los Angeles, Cal.		
1221	Special	L. W. Fox, Colton	40.73
	Guaranteed		*38.80*
1222	Special	L. W. Fox, Colton	40.48
	Guaranteed		*42.40*
1223	Special	L. W. Fox, Colton	35.94
	Guaranteed		*36.80*
1260	Special	Factory	25.64
	Guaranteed		*22.60*
1449	Special	Factory	22.59
	Guaranteed		*21.00*
1450	Special	Factory	22.50
	Guaranteed		*21.40*

*1302—69 per cent fine.

†Some hoof.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID. Available	Insoluble	Total	Guaranteed as Derived From	NITROGEN. In Nitrates	In Ammonia Salts	Organic	Organic Nitrogen Guaranteed as Derived From	Total	POTASH. From Muriate	From Sulfate	Total	Chlorin
1299	5.12	6.85	11.97	Bn, Super	1.36	0.13	2.68		4.17		4.03		‡1.40
	5.00	*5.00*	*10.00*		*1.75*		*2.25*	Bn, G	*4.00*		*4.00*		
1390	**3.12**	5.86	8.98	Bn, Super	0.96		3.19		4.15		4.53		‡2.04
	6.00	*4.00*	*10.00*		1.75		2.25	Bn, G	*4.00*		*4.00*		
1263	5.41	4.85	10.26				2.98		2.98		2.91		‡1.00
1300	**2.65**	10.74	13.39				2.82		2.82		3.56		‡1.22
	6.00	*4.00*	*10.00*	Bn			*2.50*	Bl, Bn, G	*2.50*		*3.00*		
1448	**3.36**	7.55	10.91				2.98		2.98		2.72		
1451	5.33	5.12	10.45				2.15		**2.15**		3.57		0.50
	5.00	*5.00*	*10.00*	Bn			*2.50*	Bl, Bn, G	*2.50*		*3.00*		
1391	**2.66**	7.41	10.07				2.60		2.60	1.49	1.49	2.97	1.28
	6.00	*4.00*	*10.00*				*2.50*	Bl, Bn, G	*2.50*	*1.50*	*1.50*	*3.00*	
1395	**5.04**	5.13	10.17				3.00		3.00		**3.39**		
	10.00			Bn			*3.00*	Bl, Bn, G	*3.00*		*4.00*		
1392	**4.27**	6.19	10.46				2.78		2.78	1.00	2.01	3.01	0.96
	6.00	*4.00*	*10.00*	Bn			*2.50*	Bl, Bn, G	*2.50*	*1.00*	*2.00*	*3.00*	
1453	**3.51**	8.10	11.61				3.09		3.09		4.86		
	5.00	*5.00*	*10.00*	Bn			*3.00*	Bl, Bn, G	*3.00*		*4.00*		
1301					15.86				15.86				
					15.00				*15.00*				
1452	**4.20**	6.30	10.50	Bn, Super	1.21		3.11		4.32	0.93	0.93	1.87	1.00
	10.00	*3.00*	*13.00*		*1.00*		*3.00*	Bl, Bn, G	*4.00*	*1.00*	*1.00*	*2.00*	
1258	4.46	6.32	10.78		1.18		3.03		4.21		5.16		‡2.60
	5.00	*5.00*	*10.00*	Bn	*2.00*		*2.00*	Bl, Bn, G	*4.00*		*5.00*		
1286	4.67	6.34	11.01		1.29		2.93		4.22	3.46	1.31	4.77	2.61
1393	4.38	6.52	10.90		0.46		4.04		4.50		4.99		
	5.00	*5.00*	*10.00*	Bn	*2.00*		*2.00*	Bl, Bn, G	*4.00*		*5.00*		
1285	6.53	6.79	13.32				2.03		2.03		5.21		
	6.00	*6.00*	*12.00*	Bn			*1.50*	Bl, Bn, G	*1.50*		*5.00*		
1302			15.03				4.40		4.40				
			14.00	Bn			*4.50*	Bl, Bn	*4.50*				
1221			14.16				4.87		4.87		8.27		
			14.00	Bn			*4.50*	Bl, Bn	*4.50*		*8.00*		
1222			11.91				5.29		**5.29**		8.16		
			11.00	Bn			*6.00*	Bl, Bn	*6.00*		*8.00*		
1223			15.68				3.50		3.50		7.83		
			16.50	Bn			*3.50*	Bl, Bn	*3.50*		*8.00*		
1260	9.13	1.33	10.46				2.18		2.18		4.23		0.60
	8.00		*8.00*	Bn, Super			*2.00*	Bl, Bn, G	*2.00*		*4.00*		
1449	8.38	1.67	10.05		1.80				1.80	2.45	2.45	4.90	2.34
	8.00			S	*2.00*				*2.00*		*4.00*		
1450	8.27	1.29	9.56		1.89				1.89		4.42		0.56
	8.00			Super	*2.00*				*2.00*		*4.00*		

‡Chlorin high.

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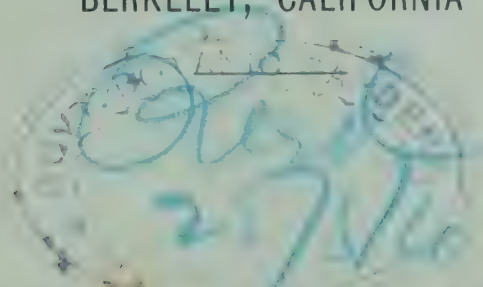

REPORT OF THE PLANT PATHOLOGIST

AND

SUPERINTENDENT OF SOUTHERN CALIFORNIA STATIONS

JULY 1, 1906 TO JUNE 30, 1909

By RALPH E. SMITH.

BULLETIN No. 203

(Berkeley, Cal., November, 1909)

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REPORT OF THE PLANT PATHOLOGIST
AND
SUPERINTENDENT OF SOUTHERN CALIFORNIA STATIONS.

July 1, 1906 to June 30, 1909.

BY

RALPH E. SMITH.

INTRODUCTORY AND GENERAL.

At the beginning of the period covered by this report, July 1st, 1906, the duties of the plant pathologist were increased by his appointment to the additional position of Superintendent of the Southern California Pathological Laboratory and Experiment Stations. By this action the Forestry Station at Santa Monica and the Citrus Experiment Station at Riverside were placed in charge of this Division, as well as the Laboratory of Plant Pathology at Whittier.

The Forestry Station is a local sub-station which has for many years been under the control of the University, as one of the several substations which were formerly conducted by the Agricultural Experiment Station.

The Citrus Experiment Station constitutes a branch of the work founded under the legislative act of 1905, in connection with the Southern California Pathological Laboratory. The idea of this consolidation of the three local branches was to handle all the sub-station work in southern California under one management. Shortly before this time the old sub-station located near Pomona was given up and the land reverted to the original owner, the work being carried on to better advantage by the newly created stations.

With the development of the Division of Plant Pathology during the six years of its existence the demand for plant disease investigation has more than kept pace. The present report extends from July 1st, '06 to June 30th, '09, covering a period composed of the second year of one biennial legislative period and the whole of another. The work of this time has therefore been divided into two quite distinct

portions. The year '06-'07, being the second year of the period from July, '05 to July, '07, was occupied by this Division largely in the continuation of several special investigations, founded on appropriations of the legislature of 1905, which have already been reported on up to July, '06, in our last report. (Bulletin No. 184, Report of the Plant Pathologist to July 1, 1906.) These were the Pear Blight work, established by a special appropriation of $10,000 for this purpose, the Walnut Blight investigation, also provided for by the State with a $4,000 appropriation, the Beet Blight investigation, supported by a private subscription of $1,000 raised by the Spreckels Sugar Company, and the Lemon Rot investigation, carried on under a fund of $1,000 contributed by the lemon interests of southern California.

During the first year covered by the present report the activities of the Division were largely confined to these special undertakings by force of circumstances. Funds in the amounts specified were fairly liberal to support the work, half of each amount being available for the year '06-'07, but it was impossible to pay much attention to other work.

During the period of these special appropriations from 1905 to 1907 it became very evident that such a method of financial support for the investigation of plant diseases is far from ideal. The result has been that while it was possible to give a large amount of attention to these problems during the period covered by the appropriations, it was impossible to lay out the work and develop the Division on a permanent basis or put it into good shape for continuous, satisfactory work on whatever problems might arise. At the end of the fiscal year '06-'07 this Division had at its disposal a considerable number of well-trained assistants who had become experienced in work in California and who would have been of great and increasing value for continued work in the investigation of different plant diseases or other lines of agricultural experimentation. As a result, however, of the discontinuance of these special investigations on pear blight, etc., at the end of the biennial period, no funds were available for keeping up this working force and they were lost to the Station. Moreover, it is extremely difficult to secure competent help for these limited periods of special work with no guarantee of regular continuance. It is certain that, with each succeeding legislature, demands will be made for appropriations to support work of the nature carried on by this Division in one part of the State or another. Yet under the conditions described it is impossible to maintain an efficient organization for meeting these varying demands at short notice.

A most satisfactory remedy for this condition was found for the southern part of the State in the establishment of the Southern California Pathological Laboratory. This institution, founded by the legislature of 1905 and now established in full working order, is maintained by regular appropriations like other State institutions, and may thus be administered efficiently and economically to carry on continuous work on the most important problems which present themselves, with no embarrassing limitations or violent fluctuations in the available funds. The Laboratory has been housed in a permanent building at Whittier, is well equipped for its purpose, has a permanent, well-organized working force and is thus able to cover this field with increasing satisfaction and with much economy to the State, as compared with the system of irregular appropriations for specific investigations or for seeking cures for certain troubles.

Previous to the meeting of the legislature of 1907 a considerable variety of undertakings was urged upon the Division with the object of seeking special appropriations for their support. This included the continuation of the pear blight work, work on the peach blight, a disease which had suddenly assumed very serious proportions, demands for local laboratories in a number of sections, suggested by the establishment of the Southern California Laboratory, and a variety of other projects. So numerous and varied were these suggestions that much confusion would have resulted had they all been presented to the legislature in the form of special appropriation bills, and the carrying out in such a form of the work desired would have been most unwieldy. It was therefore thought best to combine all these projects into one bill, asking for an appropriation to cover general work in plant pathology outside of southern California along the same lines as had proven so successful in that section. It was proposed that the office of State Plant Pathologist be created for the plant pathologist of the Experiment Station and that the laboratory at Berkeley be designated the State Laboratory of Plant Pathology, thus putting all the work of this sort in the State upon a uniform basis. This bill passed the legislature but failed to receive the Governor's signature. As it represented all the special lines of work which had been going on during the previous period, as well as the demands which had been made on the Division for the following two years, the whole work was seriously crippled and very much limited during the period from July 1st, 1907 to June 30th, 1909. Such work as has been possible during that time has been only such as could be provided for by the general Experiment Station or University funds, with the exception of that done in southern California.

Some activity has also been going on with funds derived from the Adams Fund, a national grant made for the purpose of agricultural investigation.

The bringing about of the arrangement, found so successful in southern California, for the remainder of the State was provided by the legislature of 1909 by the passage of the following Act:

"An act providing for the investigation of the nature and means of control of destructive diseases of cultivated plants in those portions of the state not benefited by the Southern California Pathological Laboratory, and making an appropriation therefor.

"The people of the State of California, represented in senate and assembly, do enact as follows:

"Section 1. The regents and president of the University of California are hereby directed to maintain in connection with the agricultural experiment work of the university in those portions of the state not benefited by the Southern California Pathological Laboratory a scientific station or laboratory with the necessary equipment for the investigation of the nature and means of control of injurious and destructive diseases of cultivated trees, plants and crops.

"Section 2. They are directed to make or cause to be made investigations of such troubles as pear blight, peach blight, olive knot, apricot failures, pear scab, apple diseases, root rot, root knot, diseases of tomatoes, potatoes, asparagus, onions and other vegetables, and such other plant diseases as may be called to their attention. They shall also furnish information and practical demonstrations to the growers of these crops as to the best means of control for such diseases.

"Section 3. The sum of fifteen thousand dollars is hereby appropriated out of any money in the state treasury not otherwise appropriated to be expended by the regents of the University of California in carrying out the purposes of this act and the state controller is hereby authorized and directed to draw his warrant for the same, payable to the regents of the University of California, and the treasurer of the state is hereby directed to pay such warrant."

Under this law it will be possible to commence systematic investigations and demonstrations on the most serious plant disease problems in northern California, and this work is now being actively organized. The law is intended to provide for permanent work similar to that in southern California, and it is hoped that the results of this work may be such as to warrant continued financial support of the State in the future, thus maintaining at the University, in reality as well as in name, the headquarters of the division of plant pathology.

In connection with this work the establishment of the University Farm at Davis has considerable promise. It is expected that opportunities will develop at the Farm for field work and practical operations of various sorts on a larger scale than can be handled at Berkeley, a very necessary feature in work of this kind.

A very gratifying feature of the development of work in plant pathology in California is the increasing tendency to affiliate the work

with that of the various Divisions of the United States Department of Agriculture. The rapid development of the Federal Department has resulted during recent years in a great increase in its activities in California. It has been the aim of this Division to so conduct its work as to operate completely in harmony with the agents of the Department and avoid as much as possible any duplication of work or misunderstanding. It is believed that the best results may be secured by segregation of the various workers on different problems or different phases of the same problem, rather than an attempt at combined work upon the same subject. So long as a clear understanding exists as to the plans and undertakings of the Station and the Department, there is no obstacle to harmonious work, and the field is broad enough for the utilization of every possible agency which can be brought into action. It is particularly undesirable, however, that representatives of the State Station and those of the United States Department should be working in the same field along more or less similar lines without such an understanding and a complete mutual knowledge of what is being undertaken.

The correspondence of the Division is continually growing, involving a great variety of questions regarding all sorts of troubles with plants, which leads to a continual broadening of the experience of those connected with the work. The practice of personal inspection on the part of the plant pathologist and his assistants, requiring a large amount of traveling to various parts of the State, is considered highly desirable for work of this sort. Though much time is consumed in this way, it is impossible otherwise to keep in touch with agricultural conditions in a State of the size and peculiarities of California. The establishment of the Southern California Laboratory has been of great advantage in this respect, furnishing a local headquarters for the work in one of the most important sections of the State.

The publications issued by this Division during the period covered by this report include Bulletin 184, Report of the Plant Pathologist to July 1, 1906; Bulletin 190, The Brown Rot of the Lemon; Bulletin 191, California Peach Blight; Bulletin 196, Eucalyptus in California; Bulletin 200, Gum Disease of Citrus Trees in California; and Circular 35, The Southern California Pathological Laboratory and Citrus Experiment Station. Numerous communications on subjects connected with the work have appeared in the horticultural press from members of the staff, as well as contributions to the programs of Farmers' Institutes, Fruit Growers' Conventions, Farmers' Clubs, and other meetings of a similar nature.

Changes in the staff of the Division have been too frequent, mostly on account of the demands of the special appropriations covering the year 1906-7 and the discontinuance of these appropriations after that time. Messrs. R. L. Adams, S. S. Rogers and F. L. Yeaw joined the pear blight work during the year mentioned. The two former have since entered the employ of the Spreckels Sugar Company, in charge of a private experiment station established by that company. Mr. Yeaw reëntered the service of this Division in December, 1907. Mr. A. M. West resigned his position as Assistant Plant Pathologist in the Southern California Laboratory on November 1st, 1906. Mr. B. J. Jones, who was connected with the pear blight work during the whole biennial period and who had charge of the field work during the most of the time, left the Division on the conclusion of this work. Mr. C. O. Smith was transferred from Berkeley to the Whittier Laboratory in December, 1906. Mr. E. B. Babcock, formerly a member of our staff, returned to the work in July, 1907. He was stationed in southern California for a time and afterwards engaged in teaching at the University, being appointed Assistant Professor of Plant Pathology on July 1st, 1908. July 1st, 1909, Mr. Babcock was transferred from plant pathology to another department of the University. The vacancy in teaching thus created has been filled by the appointment, as Assistant Professor of Plant Pathology, of Mr. William T. Horne, Chief of the Department of Plant Pathology in the Agricultural Experiment Station of Cuba. Mr. T. F. Hunt, who had been employed in the work on pear blight and beet blight, was assigned to the Citrus Experiment Station at Riverside in September, 1906. On July 1st, 1909, he was transferred to the position of chief field assistant in the northern California work. Mr. O. Butler, a graduate student in plant pathology, was employed in research work in the Southern California Laboratory from August, 1907, to January, 1909. Mr. H. J. Ramsey, who has been stationed at the Southern California Laboratory, at Whittier, as chief assistant during the whole period of this report, was advanced in title to Assistant Professor of Plant Pathology on July 1st, 1909. Miss E. H. Smith has had charge of office and laboratory work at Berkeley as heretofore. Mr. H. J. Quayle, Assistant Professor of Entomology in the University, was assigned to the southern Laboratory for entomological work, commencing July 1st, 1908. Mr. J. W. Mills, for many years in charge of university sub-station work in southern California, was assigned to the Citrus Experiment Station at Riverside upon the beginning of the work there in June. 1906. Mr. Mills continued in local charge of the development of the Station grounds until July 1st, 1908, when

he resigned to engage in private enterprise. Mr. J. H. Norton, Chemist at the Arkansas Station, was appointed Assistant Professor of Fertilization on July 1st, 1908, and assigned to work in southern California on problems of soil fertilization and management, particularly with reference to the citrus industry. On July 1st, 1909, Mr. Norton's title was changed to that of Assistant Professor of Agricultural Chemistry. Mr. N. D. Ingham, formerly employed in the pear blight work of this Division, was assigned to the Santa Monica Forestry Station in April, 1906, and still continues in charge of that work. Mr. W. B. Parker, a University student, was employed during the summer of 1908 in the olive knot investigation. Dr. J. Eliot Coit, of the Arizona Experiment Station, was appointed Assistant Professor of Pomology from July 1st, 1909, and assigned to citrus work in southern California.

REPORT ON WORK OF THE DIVISION.

The principal subjects considered in this report are as follows:

Plant Pathology at the University, Development of the Whittier Laboratory, Development of the Riverside Station, Condition of the Forestry Station, Pear Blight, Walnut Blight and Culture, Lemon Rot, Sugar-Beet Blight, Peach Blight, Rose Diseases, Apricot Diseases, Olive Knot, Onion Mildew, Brown Rot of Stone Fruits, Celery Blight, Apple Mildew, Tomato Diseases, Technical Investigations in Plant Pathology, Work in Entomology at the Southern California Laboratory, Citrus Culture and Diseases (Disease Investigation, Soil and Fertilizer Work, Pomological Work), Variety Introduction and Testing of Pecans, Peaches and Tomatoes, Eucalyptus Investigations, Work in Imperial Valley, Pasadena City Farm.

PLANT PATHOLOGY AT THE UNIVERSITY.

While the headquarters of this Division are naturally at the University in Berkeley, it has not yet been possible to develop the work there in a satisfactory degree. The funds available for this work have been so much more abundant in connection with the Southern California Laboratory than those for the remainder of the State that the former institution has come to be the principal field of the work of this Division. The teaching of plant pathology at the University has never received the attention which the subject deserves. Courses have been given in a somewhat desultory manner since 1904 by the writer and Messrs. C. O. Smith and Babcock. Commencing in 1908 the work received more systematic attention than before through the

appointment of Mr. Babcock as assistant professor of plant pathology. The department, however, has never been sufficiently equipped or housed to give extended or specialized instruction in this subject. In the field of investigation the work has also suffered in a similar manner. Following the early work of the writer from 1903 to 1905, carried on with practically no equipment or assistance, the following two years were devoted, as mentioned elsewhere in this report, to certain special investigations on a considerable scale, but without the means for general development of the department at the University. Some progress was made, however, during this period in the development of laboratory equipment and other facilities. During the past two years there has been very little more accomplished in this direction. Investigations have been carried on by Miss Smith in the laboratory and Mr. Yeaw in the field, and some problems have also been taken up by Mr. Babcock, but the development and activity of the department outside of southern California during this time has been very limited.

Conditions for the future, both in regard to investigation, experimental work and teaching at the University are much more promising. Professor Horne has been called for the purpose of assisting in building up the teaching department, and the facilities and equipment for this purpose are rapidly improving. It seems safe to predict that the teaching of plant pathology at the University will from now on receive very satisfactory consideration.

The situation in regard to investigation and experimentation, together with field work on plant diseases, in the northern part of the State is entirely changed and very much improved by the action of the legislature in passing the bill referred to on page eight. This work will be centered at the University and to some extent at the Davis Farm and can now be carried on upon a systematic and permanent basis. In general, therefore, it may be said that the Division is at last finding itself in a position to make its headquarters at the University where they properly belong and administer its work in a logical manner all over the State.

DEVELOPMENT OF THE WHITTIER LABORATORY.

The establishment of the Whittier and Riverside branches of the Station work has been described in Circular 35 of this Station. Since this publication the work of development at Whittier has gone on satisfactorily both in the laboratory building and the adjacent grounds. The laboratory is now well equipped for the work of investigation in plant pathology, entomology, and to some extent in chemistry. An

appropriation of $1500 was made by the last legislature for the further equipment of this laboratory, and with this money we intend to supply several urgent needs. A considerable part of the appropriation will be expended in the purchase of books, with the idea of obtaining a working library composed of the most necessary works needed by those engaged in the laboratory investigations. The remainder of the appropriation will be used in the purchase of a few more microscopes,

Fig. 1.—Experimental Garden at Whittier Laboratory. May, 1908.

a high-class photographic lens, and other necessary equipment. In connection with the library a good beginning has been made toward collecting as complete a set as possible of the publications of the various state experiment stations and the United States Department of Agriculture. The library receives regularly all the current publications of these institutions, and a fairly complete set of back numbers is being collected. These bulletins have all been catalogued and systematically arranged.

During the last two seasons most of the available field space at the laboratory has been utilized in growing walnuts. Considerable plantings have been made of various species and selections for the purpose of forming grafting stock for trees of improved quality to be grown and distributed by the Station for practical trial by walnut

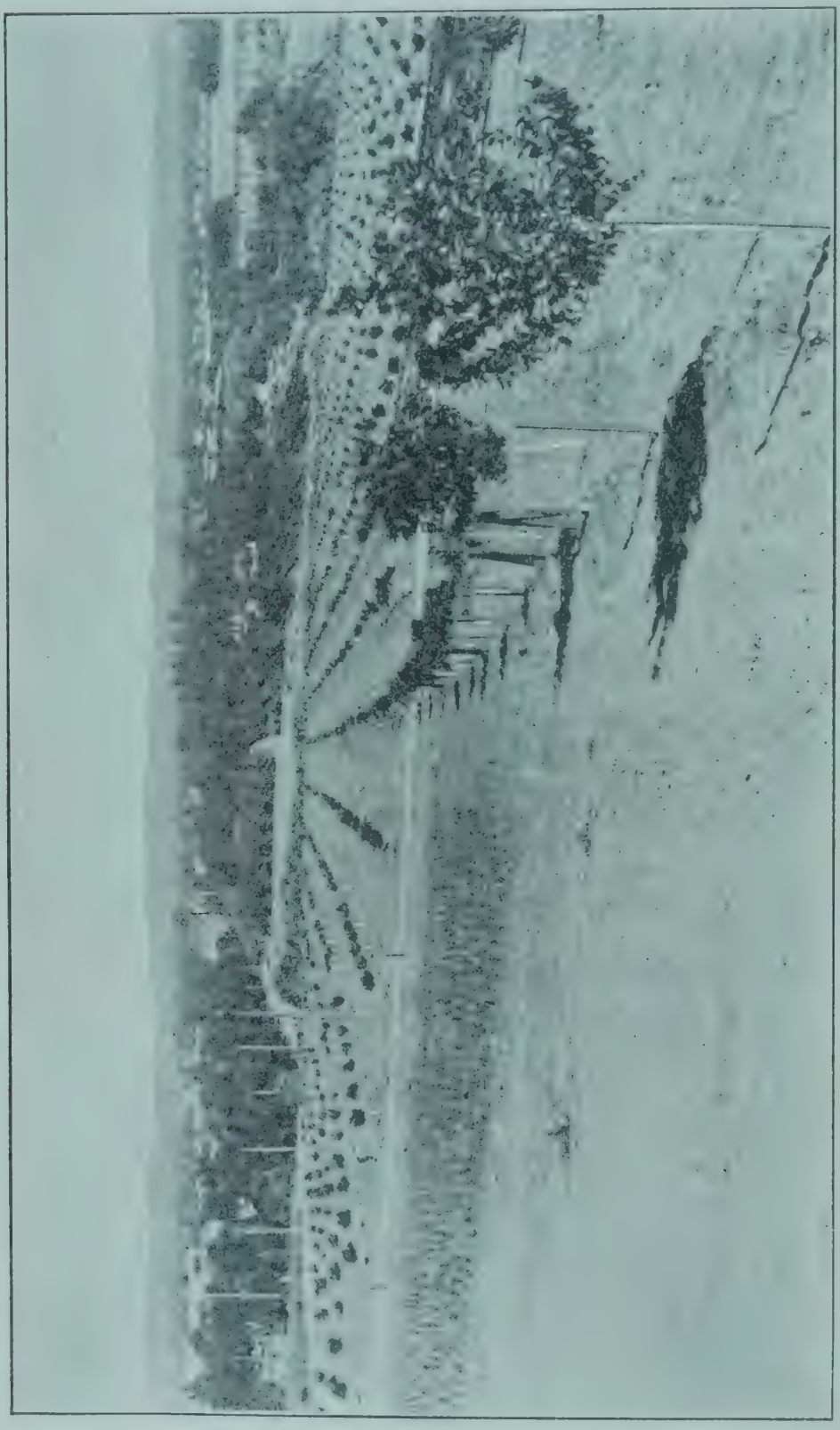

Fig. 2.—View at Citrus Experiment Station: Nursery planting in left foreground, young trees in fertilizer experiment plots directly in front, leased grove of older trees in distance. May, 1908.

growers in various sections. Considerable space has also been devoted to tomatoes in connection with the work on this vegetable. A limited number of specimen trees have been planted in the space available, representing the most important varieties of citrus and other fruits. A grove of walnut and other nut trees planted on the near-by grounds of the Whittier State School is developing well and will soon afford an interesting and valuable feature.

During the past year the development and equipment of the laboratory has been considerably advanced by the addition of Professor Quayle's work in entomology. Two rooms on the second floor of the building have been devoted to this purpose and equipped as an office and laboratory for the entomologist. A portion of the greenhouse has also been set aside for an insectary and used by Professor Quayle in his work. A considerable amount of apparatus has been added to the laboratory equipment for entomological purposes.

In the same connection may be mentioned the equipment of a small but quite complete chemical laboratory in one of the larger rooms on the second floor of the building. This room has been fitted with benches, shelves, cupboards, hood, etc., and equipment is now being installed for chemical work.

DEVELOPMENT OF THE RIVERSIDE STATION.

Work on the grounds at Riverside is proceeding well and the plantings thus far are developing very satisfactorily. The nature of the work undertaken at this Station precludes the possibility of the rapid development and progress made at the Whittier Laboratory, but every effort is being put forth to develop this Station. The plantings of young citrus trees made in the spring of 1907 for fertilizer and other experiments, as described in Circular 35 and elsewhere in this report, are making an excellent development. The citrus seed-bed stock started in 1907 has been planted out in nursery form and budded to various selected stock; a considerable planting of eucalyptus trees of various species has been made on the mountainside back of the Station; improvements in the irrigation facilities have been made from time to time, and much other work of a general nature has been done in developing and beautifying these grounds. The lines of investigation centered at this Station have been particularly those connected with field problems in citrus culture, matters having to do with studies of soil nature and treatment and pomological work. It is for such purposes that the orchard and nursery plantings on the place have been made. In connection with Professor Norton's work further development of field and cultural work is being laid

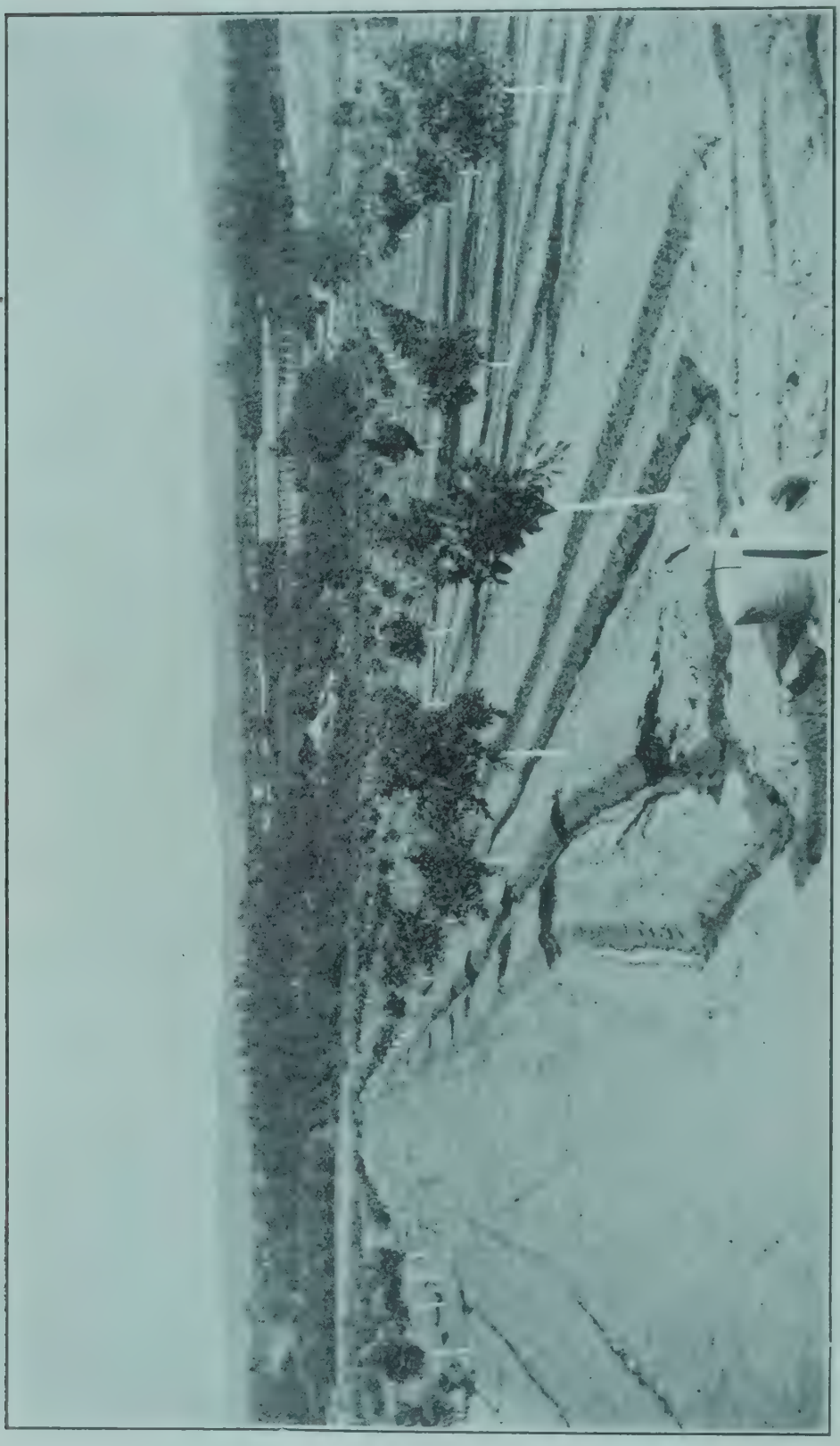

Fig. 3.—Corner of one plot in fertilizer experiment planting, showing irrigation water outlet. May, 1905.

out and a system of pot cultures is also being installed on a considerable scale. Much of the work of this Station is necessarily carried on in the commercial groves of the vicinity and elsewhere rather than on the Station grounds proper.

An effort was made during the meeting of the last legislature to obtain an appropriation for erecting a laboratory and office building on the Station grounds, but owing to the fact that this land is not owned by the State but held on a twenty years' lease, no appropriation for a building was granted. Some effort was also made to obtain an appropriation for the purchase of the land by the State, but this met with little support on account of the high value of the property, due to its favorable location.

CONDITION OF THE FORESTRY STATION.

At the time when the Santa Monica Station was turned over to this Division all the buildings of the Station had been lost by fire, and the new ones, for which plans had been prepared, had not yet been begun. The erection of these buildings was therefore the chief activity of the Station during the first year covered by this report. Two dwelling houses, a stable, tank house, lath house, green house and office were erected, so that the Station is now excellently equipped as to buildings. Much improvement in the grounds has been made by Mr. Ingham by cleaning up dead trees, underbrush and other relics of the disastrous fire which destroyed the former buildings, as well as by new plantings, road making, etc. In point of natural beauty and picturesqueness of location, the Forestry Station may be called the choicest of the University's possessions. The valuable collection of growing eucalyptus trees on the Station grounds, representing over seventy species, as well as many other trees and shrubs, was not seriously injured by the fire, and this unique collection represents the most valuable feature of the Station.

The work of the Forestry Station in previous years has consisted largely in the growing and public distribution of eucalyptus trees of various species in order to promote their trial and planting throughout the State. Since all the promising species can now be obtained of nurserymen, and with the limited funds devoted to the work of this Station, it has seemed unwise to continue this tree distribution during the period covered by this report. On the Station grounds, therefore, little has been attempted except in the way of keeping up the property and using the collection of trees growing there for purposes of study and observation.

It is evident that in the field of forestry proper this Station can

be put to no important use under present conditions. Extensive work in forestry is being done in southern California by the United States Forest Service to much better advantage than could be done by the State Experiment Station. The equipment at Santa Monica presents, moreover, no particular advantage for such a purpose. The Station's greatest field of usefulness is rather in the direction of sylviculture, in the study of planting and growing of trees as a commercial crop, for which some of the various species of eucalyptus are of great value

Fig. 4—Santa Monica Forestry Station.

in California. The work of the Forestry Station under the present management has, therefore, resolved itself almost entirely into a study of specific subjects, beginning with that of eucalyptus-growing in California, based largely on field observations all over the State where the trees are grown. This work has been done by Mr. Ingham, making the Station at Santa Monica his headquarters, and utilizing the collection of trees there as stated above. It is desirable that this collection should be duplicated in other places to provide against its loss or partial destruction from any cause, and for this reason trees of all the species represented are being grown with the idea of finding opportunities for planting duplicate collections on public grounds in California.

PEAR BLIGHT WORK.

This work, which has been carried on in co-operation with the United States Department of Agriculture, was reported on at length for the first year in our last report. The detailed history and character of the undertaking may be obtained from that publication. The second year's experience in the work, the period from July, 1906 to July, 1907, was in most respects similar to that of the first year already

reported on. The work consisted in general of an effort on the part of a considerable force of field experts to encourage the eradication of pear blight, according to the methods established by Mr. M. B. Waite of the Federal Department of Agriculture. The working force in the field consisted of Messrs. Waite and Scott of the United States Department of Agriculture, with several assistants, six representatives of this Division of the State Experiment Station and a number of men working under various County Boards of Horticulture. The plan of work was largely that mentioned on page 232 of the last report. This consisted in distributing the available men in a somewhat permanent manner among the various pear-growing districts, allowing the men in each district to render all possible assistance to the growers in that part of the State. No effort was made on the part of the Experiment Station to enforce compulsory eradication. The latter undertaking was left to the discretion of the County Boards of Horticulture, the Station men endeavoring to give all assistance of any sort which was desired by the growers in enabling them to suppress the disease. This work was continued through the winter and up to July, 1907, at which time the appropriation period ended and, no new funds being forthcoming, the work was obliged to lapse.

The general results of this two years' work on pear blight by the Station, coöperated in by the United States Department of Agriculture and the State and County Boards of Horticulture, have been by no means meagre or unsatisfactory. With the appropriation of $10,000 made by the legislature of 1905, a force of men, varying from six to twelve, was kept in the field for two years in continual earnest work; every pear grower in those sections of the State which are largely interested in this crop was visited many times and thoroughly instructed in the best known methods of handling the disease; 750,000 pear trees were carefully inspected several times; numerous meetings and demonstrations were held to promote the objects of the work; and in general it can fairly be said that to the extent of practical possibility everything was done to suppress this destructive disease. Full credit should be given to the other agencies mentioned outside of the Experiment Station for their part in the undertaking. It is difficult to see what further could be done under present conditions and in the light of present knowledge, but the work has emphasized the necessity of changed methods and increased knowledge in certain respects. Along such lines appears to be the greatest hope for the future of the pear industry in California. After the amount of work done in the field by the agents of the Experiment Station and Department of Agriculture it does not appear to the writer probable that further work of

Fig. 5.—Bartlett pear tree on ordinary root, showing mass of suckers.

this sort on a large scale could be of much profit. Our pear growers have had every opportunity to become thoroughly informed as to the methods of control advocated and to put them into practice. So far as these methods are applicable to existing conditions there should be no further necessity for their demonstration. Pear blight, however, has by no means been eradicated from California, nor is it likely to be. The future of the industry is therefore still problematical, although a considerable number of individual growers are handling blight successfully.

One of the most valuable results obtained from the work done thus far has been the experience gained as to the behavior of the disease under California conditions. Of these peculiarities there are two which seem of particular importance, since they are the factors which have most largely prevented complete control of pear blight in California; these are: first, the very large amount of infection of twigs and green shoots which occurs with no relation to the blossoms; second, the large number of trees which become infected in the body near the ground or in the butt under ground. In the latter case the blight runs down into the roots and often girdles and kills trees which, in the tops, appear perfectly healthy, or only slightly affected with the disease. So far as the usual form of the disease is concerned, occurring in the top of the tree with the infection mostly through the blossoms, our growers have learned to handle it with considerable success by the usual methods where the work is done carefully.

The one most discouraging and baffling feature of the disease has been that mentioned, where large numbers of trees in an orchard apparently free from blight would suddenly be found affected in the butts and thus beyond redemption by the methods of handling blight in the tops. Could this difficulty be overcome we believe that pear growing would again flourish on a sound basis, though requiring more care and attention than at present.

During the years 1907-09 our chief activity in regard to pear blight has been along the line suggested in the last paragraph, carried on under the provisions of the Adams Act. This work has consisted mostly in an effort to determine the method by which infection takes place in cases where the green twigs and shoots contract the disease so abundantly, and also to investigate the possibility of growing trees in such a way as to avoid the butt blight mentioned above. It has been found that the latter form of the disease is a result of the other peculiarity mentioned, the infection of the butts taking place through green sprouts or suckers, sometimes when the latter amount to no more than a bud with only one or two leaves formed in

Fig. 6—Bartlett top—worked on LeConte. Neighboring trees on ordinary root are four years older but considerably smaller.

the rough bark near the butt. Infection of this sort appears to be brought about in a similar manner to that in blossom infection, mainly by insects. Our investigations have shown that a great variety of insects which feed on the green shoots may carry the blight organism and thus produce infection. There is no apparent means of preventing this form of the disease beyond that which has already been in use, namely, the removal of sprouts from the body of the tree, and this has not proven very satisfactory on account of the continual crop of suckers produced by many trees, some of which become infected while still very small. There is also some infection through wounds made by cutting off the suckers.

The most promise is in the direction of growing trees upon a stock more or less immune, or one which is not disposed to produce sprouts, thus avoiding the infection of the trees by blight in the trunk or roots. It is well known that different varieties of trees vary in their susceptibility to blight. None are entirely immune under all conditions, but some are much more so than others.

The whole consideration of pear blight in California rests primarily upon the fact that the word "pear" in this State means ordinarily the Bartlett pear. This variety is so preëminently satisfactory that while it is one of the most susceptible to blight and other varieties much less affected are to be found, yet the giving up of the Bartlett pear would mean practically the giving up of the pear industry. The development of a new variety as satisfactory as the Bartlett, but fairly resistant to the blight, would be a most uncertain undertaking. Our chief thought has, therefore, been as to the possibilities of growing the Bartlett under some system by which the tree could be rendered less susceptible to destruction. The ordinary French seedling root upon which pear trees are commonly grown has two vital defects in relation to blight. It is very free to sucker and it is very susceptible to the disease. These suckers become infected, the blight runs down into the butt and roots, and the tree is killed while the top is still in good condition. The Bartlett pear tree trunk also suckers rather freely and blights readily. It therefore seems that it would be of great practical advantage if the Bartlett could be grown on a trunk and root somewhat resistant to blight and not given to sending up suckers. With a Bartlett top worked on this combination an orchard could certainly be kept free from serious injury much more readily than with the present style of tree.

The extensive experience gained in our work on pear blight has shown among the trees now growing in the State one suggestion of particular value. This is the growing of the Bartlett upon rooted

cuttings of the LeConte. The latter variety while by no means blight-proof, is much less easily affected than the Bartlett. It roots readily from cuttings and produces a trunk decidedly free from suckers. Trees of this combination existing in the State have shown a most vigorous growth, considerably exceeding that of the Bartlett on the ordinary root. It should be clearly understood that there is no idea that the Bartlett top would gain any immunity from blight from growing on the LeConte. The sole object is simply to grow the root and trunk free from the disease and confine the blight to the top of the tree, where it can be more readily seen and handled, and where its effects are less disastrous. As to the growth of the Bartlett on the LeConte, what experience we can gather goes to show that the tree thus grown, while unusually thrifty and vigorous, is very slow in coming into bearing. This has been learned particularly from Mr. Richard Burton, of Vacaville, who has old trees of this sort and whose experience forms the basis of most of what is said upon this subject. It has therefore been suggested that the trees be double worked, with some other variety between the LeConte root and the Bartlett top, in order to promote early bearing. The Hardy suggests itself as one possibility for this purpose, as it succeeds well in California and has shown itself to be quite free from blight. For the purpose of a thorough investigation and demonstration along these lines pear trees are being grown by this Division, trying out various combinations as to root and trunk, along the lines suggested. The results already obtained give considerable promise of success. Our main object will be to demonstrate the possibility of growing a nursery tree with a Bartlett top which can be planted in the orchard and kept free from blight simply by keeping the disease out of the top.

The seasons of 1908 and 1909 have been most remarkable in the absence of pear blight throughout the affected districts. The disease has disappeared in an astonishing manner where for the last few years it has been most abundant. This freedom from blight is evidently a climatic effect and is encouraging in showing the possibility of occasional years of little blight when a tree may have an opportunity for recovery, but should not be taken as indicating a permanent cessation of pear blight.

WALNUT BLIGHT AND CULTURE.

A large amount of work on walnut blight has been carried on in southern California at the Whittier Laboratory, and still continues. The appropriation of $4,000 made by the 1905 legislature was expended in an investigation of the nature of the disease and the pos-

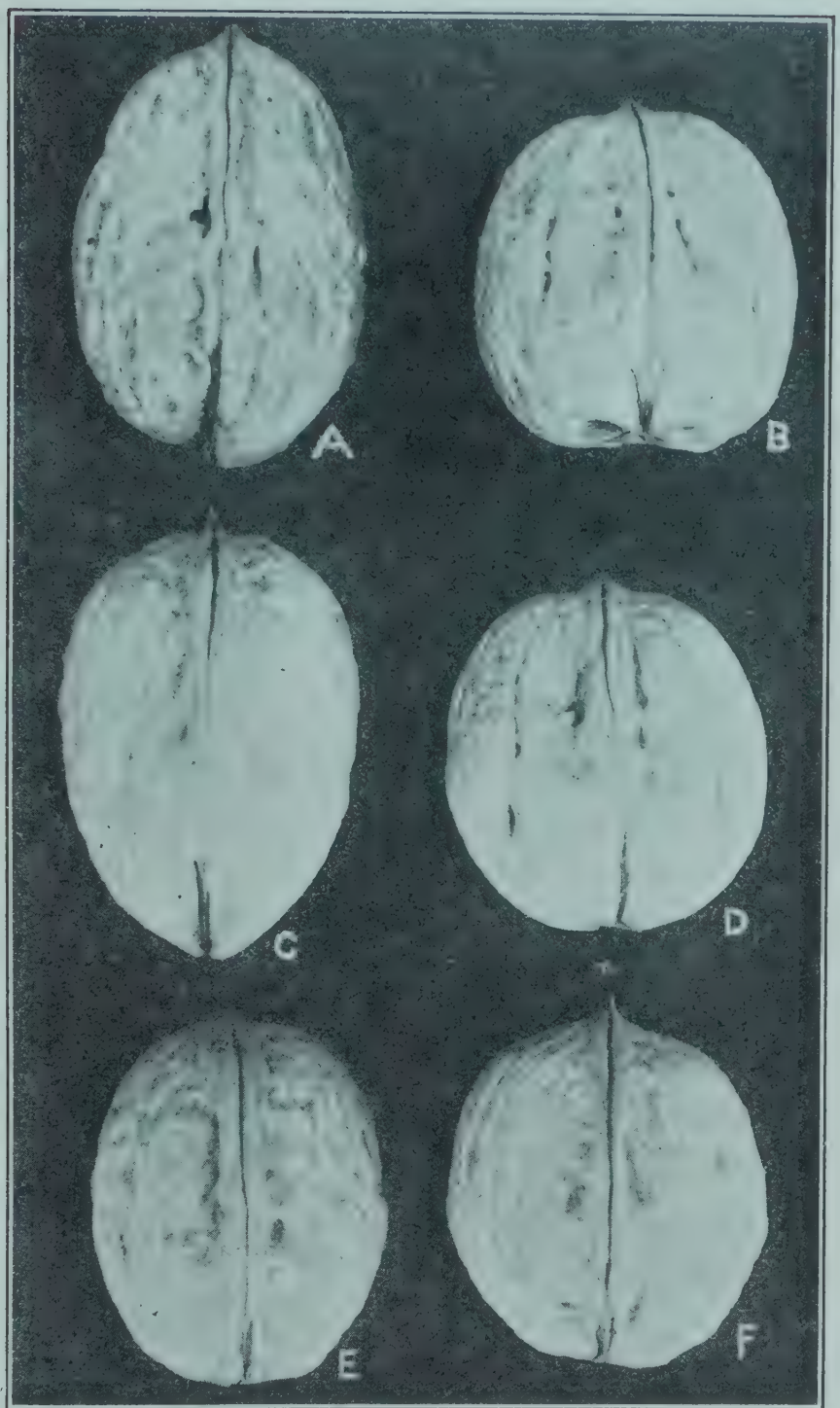

Fig. 7.—Specimens of blight-immune walnuts. A Franquette, B Mayette, C Eureka, D San Jose (Wiltz' Mayette Seedling), E Hale, F Placentia (not immune). Natural size.

sibility of its control by spraying the trees with different substances. This investigation has been made one of the chief features of the work of the Southern Laboratory since its establishment. From the experience previously gained, the idea of finding a remedy for the disease in the form of any application to the tree has been given up as impractical, and the chief effort is now being made along the lines of improved cultural practice, thus increasing the production of the trees.

The greatest possibilities in this direction seem to lie in soil fertilization, and extensive experiments along such lines are being carried on by this Division. Some of these are now in their third season and ought to show results in the crop of 1909. It is already very evident that in spite of the disease the production of most of the present orchards could be greatly increased by fertilizing the soil, if the most economical method in this respect was determined. In regard to irrigation, also, as affecting the condition of the trees, considerable benefit is being demonstrated by the determination of the best practice in this regard.

The ultimate solution of the blight problem appears to be in the growing of walnuts immune to the blight, desirable types of which are already in existence. Much work is being done at the Whittier Laboratory in this direction. This involves the growing of grafted rather than seedling trees and thus opportunity is given for choice regarding both the root and the top of the tree. Each is of great importance. Extensive plantings have been made at the Laboratory of nuts of various kinds and sources for the production of root stocks. These represent several species of walnuts and also hybrids between different species. Experience has already shown that in the native California black walnut we have a more hardy root than that of the English walnut, one that is more capable of flourishing under unfavorable conditions and one with a much wider range of soil. The native walnut varies, however, in individual trees almost as much as the cultivated species, so that there is room for careful selection and discrimination in growing a root stock. The California walnut is also divided more or less distinctly into two separate species. It may be classed as the southern California and northern California types. The tree which grows wild in the southern part of the State has its favorite habitat upon dry, somewhat elevated hillsides with occasional trees in the valleys at the foot of these hills. It is distinctly a hillside rather than a valley tree, however. The tree itself has quite a shrubby rather than a tree-like form and, even in large specimens grown on good soil with abundant

water, the tendency is still towards abundant branching rather than the formation of a tall, clean trunk. The nut of this type is a very small one. According to the latest arrangement by Professor W. L. Jepson, the southern California walnut is to be regarded as *Juglans californica* Wats. It grows quite abundantly in the Puente hills southeast of Whittier and in the Santa Monica, Newhall and other mountains of that vicinity, extending north at least to the Ojai valley back of Ventura. This species is also found to some extent in the lower parts of the San Bernardino range.

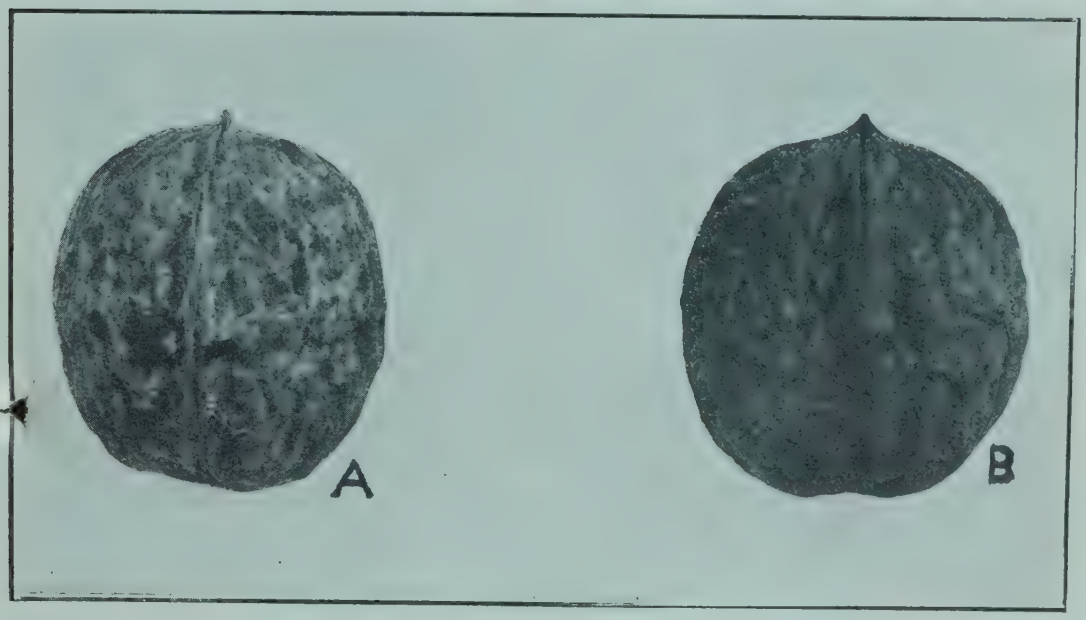

Fig. 8.—Two blight-immune walnuts: A Concord, B Chase. Natural size.

The northern California nut averages fully twice as large, and the tree has typically a tall regular form approaching that of the eastern black walnut. This is classed by Dr. Jepson as *Juglans hindsii* Jepson. The origin of the northern California walnut is much in doubt. While this tree is one of the commonest grown for shade and ornament about many of the towns in central and northern California, yet there are only a very few places where there is any indication of the tree having been indigenous. Considerable attention has been given to this interesting question and we have found but three locations where the walnut trees go back beyond the knowledge of any white person. These are: 1, near Walnut Creek, Contra Costa County; 2, Walnut Grove, Sacramento County; 3, a point in the mountains of Napa County, northeast of Napa City, near the top of the west slope of the so-called "Wooden Valley." In each of these

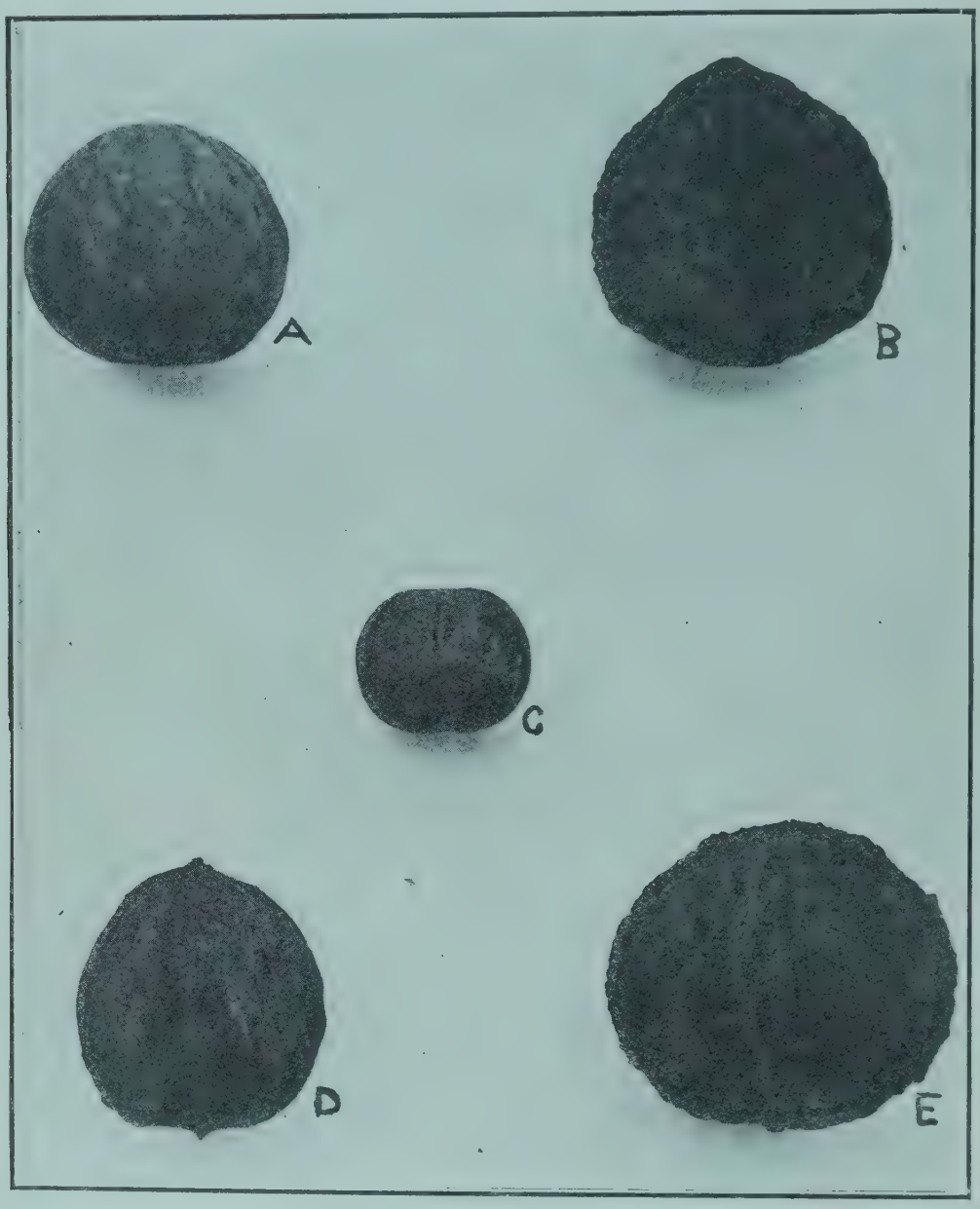

Fig. 9.—Walnuts used for root-stocks. A Northern California Black (*Juglans hindsii*), B Eastern or American Black (*J. nigra*), C Southern California Black (*J. californica*), D Hybrid English X *californica*, E Hybrid, *nigra* X *californica*.

places, and at no other which we can find, there were large old black walnut trees growing at the time of the first white settlement. These primeval trees do not appear to have been indigenous to the localities where they are found, but the question of their origin is an extremely obscure one. Morphological and field studies are being made by Mr. Ramsey upon this subject. The northern tree shows a decided preference for a moist valley soil in the vicinity of streams rather than that of the south for growing on dry hillsides.

Both the northern and southern California walnuts have been found satisfactory as a root stock for the English, but we have as

Fig. 10.—Top-grafted walnut trees, March, 1908.

yet no sufficient comparison between them to judge finally as to which is the better. Such comparisons are now being made by this Division by grafting English walnuts on various roots and planting them in various soils. The possibility of using for roots some of the not uncommon hybrids between the California black, American black and English walnuts is also receiving much attention, on account of the extremely vigorous growth of these trees. Selected walnuts from all over the State as well as from other parts of the country have been planted at Whittier, and a very interesting nursery is in process of development.

The selection of a strain or variety of English walnut possessing immunity to the blight as well as desirable commercial qualities is receiving much attention. Immunity to this disease is not obtained

entirely by actual resistance, but in many cases by simply escaping the worst infection period: *i.e.*, the moist weather of early spring. Most of the immune trees are such as come out rather late in the spring, thus escaping rather than resisting the blight. Several of the ordinary French walnuts, such as the Franquette and Mayette, have this quality of lateness in an extreme degree, but this involves

Fig. 11.—Same trees as in figure 9; July, 1908.

the question of the time of harvest in the fall, an extremely late crop not being desirable in California. The most promising trees found thus far are local seedlings of foreign varieties which develop somewhat later than our ordinary seedlings, but not so late as the French varieties mentioned. A number have been found which seem to justify their planting as blight-immune. Among these we may mention varieties which have received the names Eureka, Concord, Chase, and San Jose, as well as the Franquette and Mayette mentioned

above. All of these and many other varieties are being grown by this Division and their value carefully tested for various portions of the State. We are now in a position to supply scions of all the important walnut varieties, as well as a limited number of nursery trees of some.

Fig. 12.—English walnut grafted on California black.

One very imperative phase of this matter has been the question as to the fate of the present existing plantings, consisting of many thousand acres of fine, large, thrifty trees, very satisfactory in every way except for the occasional loss of a considerable part of the crop through their susceptibility to the disease. Many of these orchards are extremely profitable, even under present conditions, and it is

evident that by increased attention to soil fertilization their productiveness can be maintained in a very satisfactory degree in spite of the disease.

One means of handling large trees which are extremely susceptible to blight is by top grafting them to the more immune kinds. The methods of doing this have received the consideration of this Division, and much work has been done along this line. During 1908 and 1909 a considerable number of large trees were top grafted, both by the Station and by individual growers, with decided success. Experience elsewhere, particularly in the central part of the State, where many large native walnuts have been grafted to the English variety, has shown that with reasonable success a new top equal to the original one can be put on a large tree in four years. In orchard work the most rational practice appears to be the picking out and working over of the trees most susceptible to blight each year until finally the whole orchard has been changed. In this way there is no marked loss from cutting off the trees in any one season.

Another method of working over an old orchard consists in intersetting with nursery trees of the California black walnut. It is more practical to plant the young trees rather than the nuts in the orchard. The object of this method is to grow the black walnut trees up to three or four years old and then graft them in the top to the desired variety. If the ground is closely shaded by old trees they should be thinned enough to give the young black walnuts a chance to grow. This thinning can be done in most of our older orchards without any disadvantage, as in most of them the trees are already too thick. The young grafted trees will come into bearing early, and it is possible by this plan to have a new orchard well started by the time it is necessary to cut out the old trees. The advantage of a tree having the black walnut trunk as well as root is a very considerable one, owing to the susceptibility of the English walnut trunk to sunburn.

The publication of a bulletin on walnut blight and walnut culture in general is contemplated for the present year.

LEMON ROT INVESTIGATION.

The investigation of the form of lemon decay known as "Brown Rot", which was begun in July 1905, was practically completed during the year 1906-7 and reported on in full in Bulletin No. 190. Successful means of preventing the great losses which had occurred from this trouble were found and a detailed account of the whole subject may be found in the bulletin mentioned. This work has led to fur-

ther investigations upon lemon decay and other phases of the lemon business at the Whittier Laboratory.

SUGAR-BEET BLIGHT INVESTIGATION.

The blight or curly top of the sugar-beet has been a subject of investigation in this Division for some time, as mentioned in our last report. This work has been in coöperation with the Spreckels Sugar Company and other beet growers of the State, continuing during the period from the spring of 1905 to the fall of 1906. In 1907 the company mentioned took two of our assistants into its own employ and has since then continued the field work through them.

Some investigations of a technical nature are being carried on in relation to the nature of this disease at the Whittier Laboratory. From the work thus far it appears to be well established that the trouble is largely influenced by meteorological factors varying from one season to another.

PEACH BLIGHT INVESTIGATION.

Active work on this subject was completed in the winter of 1906-7 and a bulletin on the subject (Bulletin No. 191) published in September, 1907. Work during the year mentioned consisted mostly in extensive field work and demonstrations, having for their object a general application of the method of treatment found successful in previous years. This work came to a very successful conclusion, as described in the bulletin mentioned.

ROSE DISEASE INVESTIGATION.

Owing to the delay in publication of a bulletin on this subject, which was promised in our last report, it has been possible to gather other data to supplement that previously obtained. During the past two seasons a thorough survey has been made of the various varieties of roses growing in most of the important nurseries in the State, as well as on private grounds, in order to determine the relative degree of susceptibility of the various varieties to the usual rose diseases.

Further work on the treatment of the rose mildew has also been carried out on a considerable scale during the past season.

APRICOT DISEASE INVESTIGATION.

Work on this subject has been carried on for some time in connection with the peach blight work and has received special attention during the years 1907-09. The main object has been to determine

Fig. 13.—Apricot buds killed by peach blight fungus, *Coryneum beyerinkii.*

the nature of the trouble with apricots which so reduced the crop in the State for several years previous to 1908 and to determine the extent to which the apricot is being affected by the peach blight fungus, *Coryneum beyerinkii.*

We are convinced that the death of the fruit buds of the apricot previous to blooming which has been so prevalent in many localities, may be due to the fungus just mentioned, and that a spotting of the leaves and fruit at an early stage is also caused by *Coryneum.* This spot is quite characteristic, usually less than a millimeter in diameter, red, with light centre. It is distinct in appearance from any other apricot spot which has come under our observation, but might

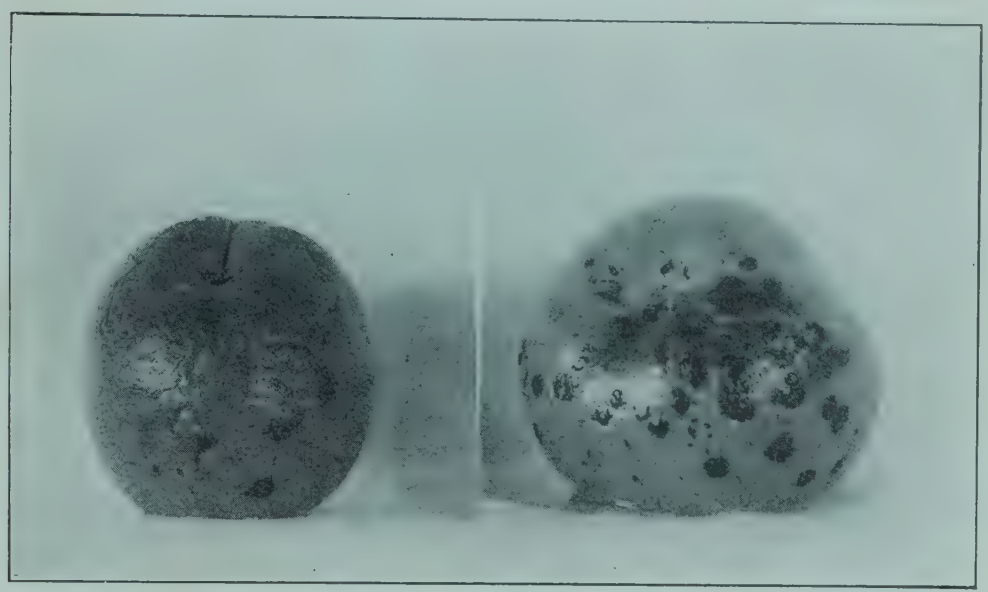

Fig. 14.—Black spot of apricot fruit, caused by *Cladosporium.*

easily be confused with a seemingly physiological effect which is very general. This is a reddish dot, smaller even than the *Coryneum* spot and less definite in outline, which at its minimum is nearly always present, and might almost be called a normal condition of the fruit. Its cause is not yet understood, but it does not appear to be a parasitic disease. It is quite possible that this is the "apricot scab" which is claimed to have been prevalent in the State many years before the *Coryneum* blighting of the buds began. This can only be determined by observation of the fruit during "off years" for *Coryneum* blight for a number of seasons. Such was the year just past, and so far as the writer has been able to observe there has been comparatively little spotting of the fruit in most sections. What has

Fig. 15.—Apricot "Scab" and "Shot hole."

come under our observation may be classed under three heads: *Coryneum* spotting (very slight), the physiological effect (rather more than the *Coryneum*), and a black spot of apricot, which has been rather prevalent in some sections.

The black spot was first sent us for identification by Mr. Earl Morris, Entomologist for Santa Clara County. It is caused by a fungus, *Cladosporium carpophilum*, described by von Thümen and since reported by Arthur, Smith, and others as damaging peaches and plums. The fungus forms a thin, black coating in spots about 2-3 mm. in diameter when isolated, which causes the fruit to dry and crack, especially when the spots are confluent. It attacks the fruit later in the season, and is in every way distinct from the *Coryneum* spot.

The uncertainty of the apricot crop during recent seasons and its susceptibility to climatic conditions has rendered difficult the determination of the actual causes of these troubles. From experience thus far it appears that the *Coryneum* treatment recommended for peaches, in Bulletin No. 191, consisting of two sprayings with Bordeaux mixture, one in November and the other in February, will prove as effective with apricots as with peaches.

OLIVE KNOT INVESTIGATION.

The knot or Tuberculosis of the Olive has been known in the State for several years, but until a comparatively recent period did not seem to assume a very serious aspect. Bulletin No. 120 of this Station was published several years ago on the subject, describing the disease quite fully. In some sections the trouble has now developed to such an extent as to make its control seem quite necessary for the future of the industry, so many trees having become badly affected. On this account coöperative arrangements were made during 1908 with olive growers in certain sections where the disease is most troublesome and investigations started in an effort to obtain further information concerning this trouble. It seemed particularly desirable to learn the method and source of infection in the olive knot disease concerning which we have hitherto had no information. This work was carried on during the summer of 1908 by Professor Babcock and Mr. W. B. Parker and will continue to receive attention. It is highly probable that a definite mode of infection will be found which may give an important clue to possible means of control.

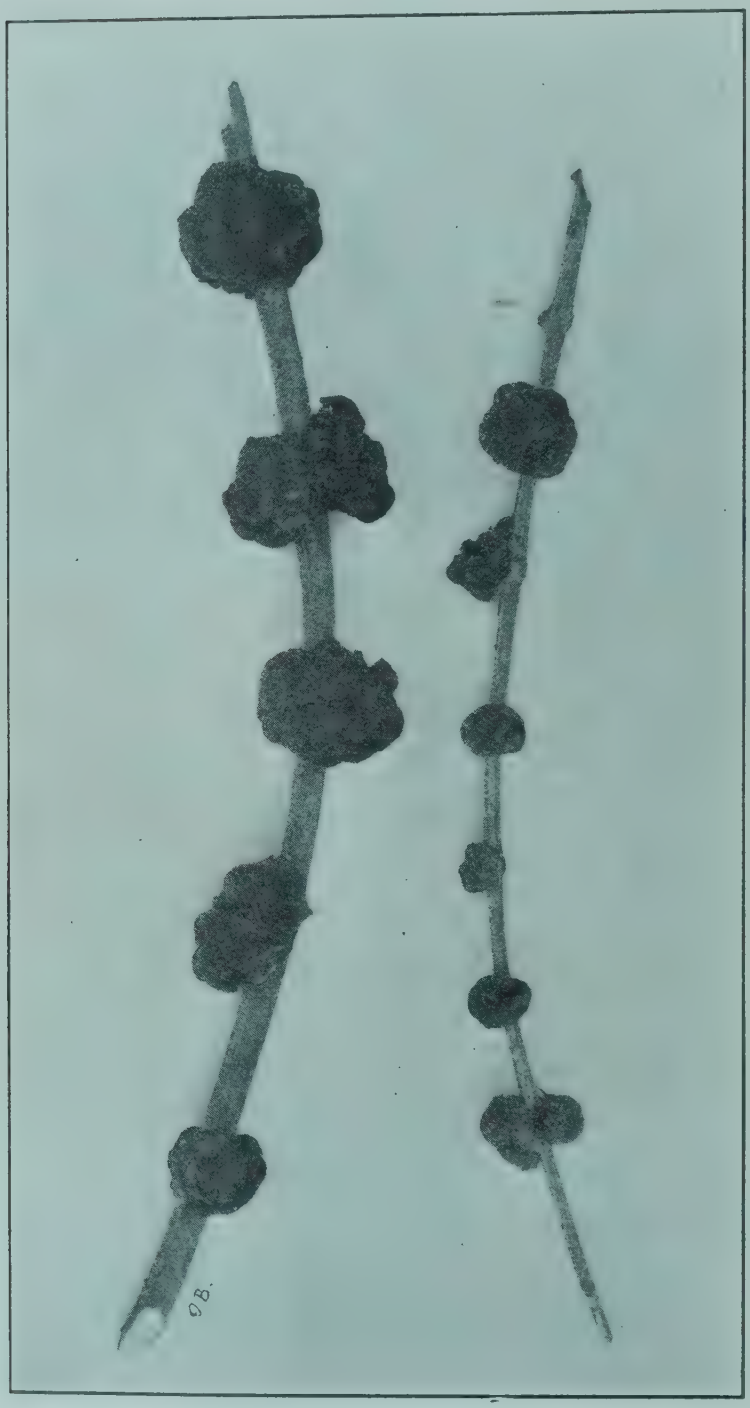

Fig. 16.—Olive knot.

ONION MILDEW INVESTIGATION.

The growing of onions for seed is a large industry in California. In connection with this business much trouble has been experienced for a number of years on account of the attacks of a fungous disease, the Downy Mildew of the Onion (*Peronospora schleideniana*). This fungus makes its attack on the leaves and seed stalks of the plant during moist weather, causing large losses in the crop. Its occurrence varies from year to year on account of climatic conditions, and for this reason we have never been able to secure satisfactory demonstrations as to the possibility of controlling the trouble by spraying. During the season of 1908 spraying experiments were arranged by this Division more extensively than ever before with the hope of finding a practical treatment for controlling the trouble. The season was not a favorable one for the disease, however, so that the results secured have not been satisfactory.

Fig. 17.—Brown rot of plum. (*Sclerotina.*)

BROWN ROT OF STONE FRUITS INVESTIGATION.

What has been said of the preceding subject applies equally well to the present one. This fungus (*Sclerotinia fructigena*), which causes a very destructive decay of peaches, plums, apricots, etc., when conditions are favorable, varies in its occurrence in this State with the character of the season as to moisture. The trouble has never become general over the State, but in seasons with late spring rains has been very troublesome in the San Francisco Bay region on early

peaches, apricots and certain varieties of plums. During 1908 arrangements were made for careful spraying demonstrations at a number of points in the affected region, and the Division was prepared to give the matter thorough attention. On account of the dry season, however, there was practically no occurrence of the trouble. It appears probable that in seasons with late rain a spraying with any standard fungicide not injurious to the foliage, directly following each rain after the crop is set, would control this trouble quite effectively. In the case of brief showers followed by drying weather, the brown rot is not likely to develop and spraying is not necessary.

Fig. 18.—Celery field, Smeltzer, Cal.

CELERY BLIGHT INVESTIGATION.

Another important work is that which has been begun in coöperation with the celery growers of the extensive Orange County district. In the peat lands of this section, located between Santa Ana and the coast in the vicinity of Smeltzer, a very large celery growing industry has developed, the crop being grown particularly for shipping during the winter after the eastern celery has had its season. During the summer of 1907 nearly 6,000 acres of celery were planted in this district. Great losses in the crop were experienced in the winter of

Fig. 19.—Celery blight, caused by *Septoria petroselini var apii.*

1908 from a fungous disease causing a blight of the leaves of the celery plants and heavy decay during shipment. (*Septoria petroselini*, var. *apii*). These losses were estimated as causing a shrinkage of 1,950 carloads in shipment and had a most disastrous effect upon the quality of the celery on arrival in the eastern markets and the financial returns from the crop. The whole money loss of the season caused by this fungous disease was conservatively estimated at $550,000.00.

Spraying the plants in the field with Bordeaux mixture was tried by a few during this time with decidedly beneficial results, even though not begun until the disease had already appeared.

As a result of this experience and with the knowledge of the successful control of this disease in other sections by such spraying, the Orange County Celery Growers' Association, which comprises practically all the celery growers of that section, made plans for a general spraying campaign during the season of 1908-09. Copper sulphate and lime were purchased in large quantities by the Association and practically every grower sprayed his fields faithfully and to the best of his ability throughout the season. The acreage planted was much less than that of the year before, amounting to only about 2,700 acres. The spraying thus carried on by the various growers naturally varied a great deal in regard to thoroughness and other details, but resulted in general in a most striking demonstration of the value of such work. In unsprayed fields the blight was as bad or worse than ever before, but as a result of the spraying done by the members of the Association the crop was carried through in excellent condition, put on the market in the best of shape, and the financial returns were exceptionally good. The Division of Plant Pathology was able to be of considerable assistance in the matter by occasional inspections and the giving of advice and instructions in regard to the spraying operations. There is still a large field for work in this direction in perfecting the methods of preparing and applying the spray to fit the particular needs of the celery growers, and also in demonstrating the most economical and effective practice in regard to time, frequency and other details of spraying. This work will be carried on by the Division during the coming season on a somewhat more extensive basis than heretofore, in coöperation with the Celery Growers Association, the California Vegetable Union, and the Golden West Celery and Produce Company.

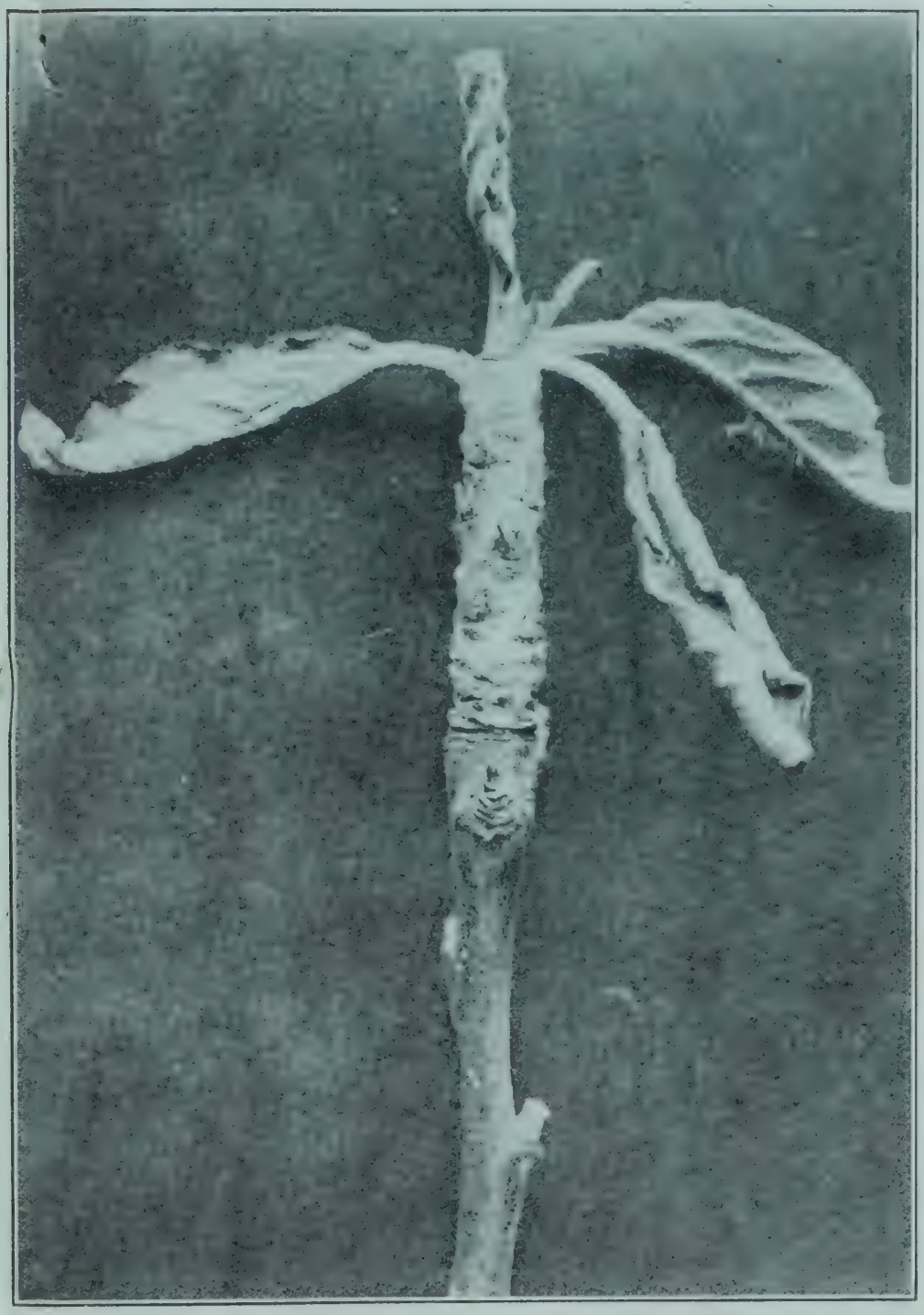

Fig. 20.—Apple mildew.

APPLE MILDEW INVESTIGATION.

The powdery mildew, one of the worst troubles affecting apples in California, has become abundant in all parts of the State where apples are grown. The Division has been carrying on spraying investigations in coöperation with growers in an effort to determine the best method of control for this disease. Results thus far indicate the best success from treatment with sulphur- or sulphide-containing sprays in the spring and early summer.

TOMATO DISEASES.

The investigation of tomato diseases has received considerable attention ever since the beginning of the southern California work. One of the most important branches of tomato growing in that section has come to be the crop which is matured late in the fall for eastern shipment. This enterprise has proven extremely successful, except for one drawback. This is the prevalence of the common potato-blight fungus (*Phytophthora infestans*), attacking the tomato vines in seasons when rain occurs early in the fall. During the fall of 1907 the whole acreage of tomatoes was completely ruined in this manner before active shipments had begun, making the crop a total loss. Demonstrations by the Laboratory at that time, however, showed the possibility of entirely controlling this disease by means of spraying the vines with Bordeaux mixture following the rain. Preparations were made by this Division and by the growers to carry out such spraying on a large scale during the season of 1908, should weather conditions make it necessary. The season was not such, however, as to favor the extensive development of the blight, so that extensive spraying was not required. Such spraying, however, like all other work of the same sort, is of the nature of insurance and should be prepared for each year, whether conditions make it necessary or not.

The method of procedure in regard to the spraying operation itself is a very simple one, consisting in spraying the vines thoroughly with Bordeaux mixture, made by mixing together blue stone (copper sulphate) and lime water, using 5 pounds of the former and 5 pounds of unslaked lime to 50 gallons of water. The blue stone is dissolved and the lime slaked in separate portions of water, and the two then diluted and mixed together, running them through a strainer. The chief problem involved is much the same as that with the celery disease; namely, that of getting a large acreage properly sprayed at the proper time. It is to this phase of the matter in each instance

that this Division is paying particular attention, working through the coöperative associations into which the growers of these crops are united.

Considerable work of an experimental nature has been carried on at the Whittier Laboratory on the subject of the prevention of damping off of tomato plants in the seed bed by chemical soil treatment. This trouble causes severe loss almost every season, both in tomato and other plants. Our results thus far have not been especially promising. The experiments have been mainly in the treatment of soil with dilute solution of formaldehyde and sulphuric acid.

The best results in growing plants have been obtained by careful attention to proper watering and soil preparation, obtaining as thrifty and vigorous a growth as possible without oversaturation of the soil with water.

TECHNICAL INVESTIGATIONS IN PLANT PATHOLOGY.

In addition to these more practical lines of work having immediate field application, the very favorable resources of the Whittier Laboratory are also being made use of for various lines of technical research in connection with the work of this Division. Opportunities are offered for the work of graduate students at the Laboratory in special investigations. Work of this nature which has been going on includes an investigation of various species of *Fusarium,* supposed to be the cause of diseases of various plants; also the study of several of the so-called physiological plant diseases, based particularly on the "Curly Top" of the sugar-beet and the aster "Yellows."

WORK IN ENTOMOLOGY AT THE SOUTHERN CALIFORNIA LABORATORY.

The work and usefulness of the Whittier Laboratory has been greatly broadened during the past year by the commencement of investigations in entomology by Professor Quayle. The problems of insect control in Southern California have received an unusual amount of attention from a purely economic standpoint, but until recently there has been very little careful investigation made concerning destructive insects of this portion of the State from a biological standpoint. Among the important problems in entomology those concerning citrus insects are much the most prominent, particularly in the case of certain scale insects. Mr. Quayle has therefore devoted his principal attention to the commencement of a thorough study of the biology of the most important insect enemies of citrus trees. Chief among these are the four scale insects which are most prominent, the

so-called black, purple, red, yellow, and soft brown scales (*Saissetia oleae* Bern., *Lepidosaphes beckii* Newm., *Chrysomphalus aurantii* Mask., *Chrysomphalus aurantii* var. *citrinus* Coq., and *Coccus hesperidum* Linn.)

Each of these species has received careful study in the field, laboratory and insectary to determine exactly its life habits and the whole course of its development. Other citrus insects which are also receiving attention are the mealy bug (*Pseudococcus citri* Risso.) and the cottony cushion scale (*Icerya purchasi* Mask). It is our intention to continue and extend these studies in the future and also to build up collections of southern California insects, and in other ways to make the Whittier Laboratory a center of entomological research in southern California.

CITRUS CULTURE AND DISEASES.

One of the most important undertakings of this Division is the study of citrus culture, this work being prominent both at the Whittier Laboratory and at the Riverside Station. The whole subject of citrus culture demands more and more attention from scientific investigation as the industry grows older, and the station founded at Riverside especially to meet this demand has possibilities of a most useful development, while at the same time its responsibilities to the industry are great.

The commencement of this citrus work under the direction of the Division of Plant Pathology should by no means be looked upon as an indication of a narrow scope or limited field in the future of the work, or that it is expected that its many phases will be covered in a superficial manner by work from a single standpoint. It is rather the intention to make these Stations centers of research on problems relating to citrus culture, developing facilities and special departments as rapidly and efficiently as possible.

Disease Investigations.—The study of diseases or failures of citrus trees in California is a most complicated problem. This is due to the fact that the chief troubles are not of parasitic origin, but are due to abnormal physiological conditions brought about by the artificial environment under which the trees are grown. The exact nature of these troubles is in most cases extremely difficult of determination, while a demonstration of a remedy or corrective for the same is even more difficult. The case is very different from those where fungus or similar diseases occur. In fact, it is not entirely a question of health and disease with the citrus crop, but rather one of commercial perfection and its opposite; in other words, the per-

fection of desirable commercial qualities is by no means the same as natural development or natural health. The fact is that the work of the plant pathologist in California with citrus fruits is not limited to the study of actual disease and the means of avoiding it. He is rather called upon to advance commercial perfection and learn how to overcome conditions which are undesirable from this standpoint, whether they be ones of actual disease or not. For this reason it is natural that problems of soil fertilization and other cultural considerations should be closely associated with the work of the pathologist, since they cannot be sharply segregated.

A thorough study of what may be called the actual diseases of citrus trees in this State is being carried on in Southern California, both in the field and laboratory. As a result of this work thus far it may be said in general in regard to citrus diseases that almost nothing has been found which may be ascribed to the effects of any parasite. If we except decay of the fruit and a very few minor cases, the above statement may be made an absolute one. It is a fact beyond question that the most serious troubles with citrus trees in California are the effects of unfavorable natural conditions and not those of fungi, bacteria or other parasites. Some of these effects are at present most obscure, and difficult or impossible to account for in any satisfactory manner. Yet the study of the various diseases and of the nature of the tree itself has been sufficient to show that the above statement is true.

The citrus disease investigation is being conducted in the field by various members of the staff, while a large amount of more technical work is being done at the Whittier Laboratory in the preparation and microscopic study of affected tissues.

The particular diseases or troubles under consideration at present may be named as follows: Gum disease of the lemon, scaly bark of the orange, Florida die-back (Exanthema) of the orange, puffing, splitting, brown spot and staining of the orange, and pitting of the lemon. These are all serious troubles affecting very materially the production of groves and the financial returns from the fruit. The results of investigations on the first three subjects mentioned have been reported in Bulletin 200, "Gum Disease of the Citrus Trees in California." In this work the nature of these diseases was quite fully established and practical means of control demonstrated.

The so-called "brown spot" of the orange is a subject which received considerable attention during the past year. This is a peculiarly obscure problem, and no positive results have been obtained as to the nature of the trouble or methods for its control. The disease

Fig. 21.—Orange scaly bark.

shows itself in the form of dark-brown sunken spots of considerable size on the surface of the orange. These spots are not visible while the fruit is on the tree or when freshly picked, but develop within two or three weeks after picking, thus appearing mostly after the fruit has reached the eastern markets. The spot affects the most fancy, smoothest fruit worst and occurs abundantly only in certain sections. We feel safe in saying that it is not caused by any insect, fungus, bacterium or other living parasite and is not the effect of fumigation, spraying, ordinary frost or any such thing. The spot itself is simply a portion of the rind which weakens prematurely and becomes dead, dry and dark colored. Some influence must act upon the fruit at some time previous to the beginning of the picking season which causes the rind to be injured or weakened in these spots. It seems most likely that this influence is connected with some climatic condition peculiar to the region in which the trouble occurs. A large amount of negative information was obtained during the past season which is not without value in simplifying and more clearly defining the problem. The work will be renewed next season in a further effort to discover the real nature of this spotting.

In addition to these more specific diseases, investigation is needed in many cases of failures or troubles with trees which are occurring abundantly. This work commonly involves soil studies and chemical investigations of various sorts, and herein is illustrated the close correlation of such investigations with plant pathology proper in citrus work.

Soil and Fertilizer Work.—The work on citrus culture in general which has thus far received the most attention is that relating to the fertilization of the soil. This is one of the most important and at the same time most complicated problems which face the California citrus grower. The attention of the Experiment Station for many years has been directed to a considerable extent in this direction, yet as the industry advances the demand for information becomes more and more specific, and the problems more and more obscure. If the general vigor and growth of the trees were the only question involved, or even their quantitative product, present knowledge would be fairly sufficient. With the problem complicated by the relation of fertilization to certain definite qualities of the fruit, desirable and undesirable, likewise questions affecting the physical quality of the soil and its treatment, the mere matter of fertility becomes almost of secondary importance. A large amount of investigation of the matter from many different standpoints will be needed to make the Citrus Experiment Station a practical success, measured by the de-

mands awaiting it. As a fundamental basis of the work upon fertilization, it has seemed desirable to determine more definitely than is now known the specific effects of the various fertilizing elements upon citrus fruit. For this purpose a ten-acre planting of young trees has been started, as described in Circular 35, made up of twenty small plots, upon which the application of the various single elements and combinations has been begun. This should show more definitely than is known at present the results of such applications. Similar experiments have also been begun to a limited extent upon trees of mature size in an orchard adjoining the Station grounds, which has been leased for this purpose.

Other fertilizer experiments have also been begun for the purpose of testing the effects of certain materials and also in regard to different amounts of complete fertilizer as affecting the comparative amount of the fruit. A series of coöperative fertilizer experiments, which was begun by the Experiment Station several years ago under the direction of Professor Stubenrauch and carried on by Mr. J. W. Mills, has been continued by the Citrus Station. In the majority of cases, however, these experiments were not continued long enough by the various growers in whose groves they were being carried on to give any definite results. Only a very few are being kept up at present, and the uncertain nature of the results even in these is sufficient to show the extreme difficulty of conducting satisfactory fertilizer demonstrations in the ordinary grove, although coöperative experiments of a simple nature adapted to commercial practice can be arranged with growers in various sections. This has been done already to some extent by the Citrus Station since its establishment, carrying out demonstrations on the improvement of unfertilized groves by the use of complete fertilizers in different amounts, the application of specific elements in certain cases and other similar undertakings.

The work of the Station concerning soil nature and treatment has been greatly broadened during the past year by the appointment of Professor Norton to our staff. His work has been commenced along the line of seeking more accurate information and data in connection with soil treatment than is now available. The principal problem upon which his investigations have been begun is that connected with the addition of humus to the soil. Careful studies have been started concerning the various cover crops on the basis of measurement of tonnage produced, chemical analysis and the question of nitrogen fixation, the latter in connection with pot experiments. Other important problems relating to soil improvement, fertilizer, etc., will be

taken up and this work laid out on a permanent and thorough basis. Professor Norton will also be able to devote some attention to crops other than citrus in connection with his soil studies and chemical work.

Pomological Work.—A beginning has been made at the Riverside Station of considerable work of a pomological nature in relation to citrus fruit. This includes particularly the improvement of varieties by bud selection and the testing of various citrus species for root stocks. A considerable nursery has been started in which are growing orange and lemon trees which have been selected from trees showing various peculiar characteristics of a desirable kind, and also a large amount of root stock of various species.

The addition of Professor Coit to our staff will give greater breadth and strength to work along pomological lines.

VARIETY INTRODUCTION AND TESTING OF PECANS, PEACHES AND TOMATOES.

The facilities available at Whittier and Riverside for growing trees and plants has made possible a beginning of the introduction and testing of various cultures of certain sorts.

Pecans.—The growing importance of pecan culture in the southern states has awakened considerable interest in the possibility of the production of these nuts in California. The subject was brought to the attention of this Station through its work with walnuts, and, being of a similar nature, has been given some attention. Pecan trees are growing in various parts of California and thrive well. Their production is a matter of much variation in different sections and with different trees. In general, however, the interior valleys of the State where the summers are hot and the winters fairly cold seem better adapted to pecan culture than the coast regions. Many trees in the State fail to produce, or ripen their nuts very irregularly, on account of the mild climate and lack of definition of the seasons.

Of the many improved varieties of pecans which are now being grown in Texas, Florida, Georgia, Louisiana, Mississippi, etc., very few have been tested in California, and none for a long enough time or generally enough to demonstrate their adaptability to this State. During the winter of 1908 trees were obtained by this Division of about thirty of the leading varieties from various nurseries in the southern states. These were planted on the grounds of the Whittier Laboratory and are all growing well at present. A large number of pecan

nuts were also planted in the nursery, and upon these seedlings the various varieties will be propagated and the trees thus obtained distributed for trial in different parts of the State. In the spring of 1908 trees of a few varieties obtained from nurseries were also planted at a few different points in the State for the same purpose of demonstration.

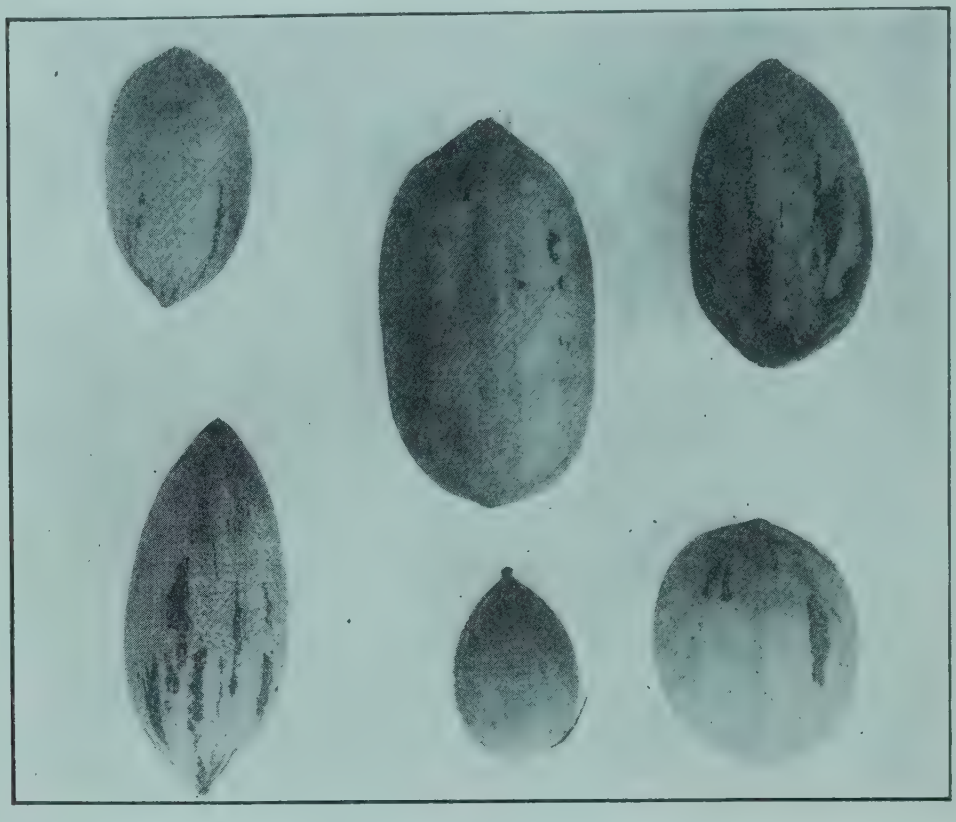

Fig. 22.—Pecans: Large variety is Frotscher, the others seedlings, showing variation in size and shape.

Peaches.—Another somewhat similar project has been begun with peaches adapted to growth in southern California. In this section of the State the production of the usual commercial varieties has been quite uncertain, owing to the mildness of the winter climate. The success in Florida and other southern regions of many varieties of the Honey and other Chinese peaches has suggested the possibility of developing varieties from such a source of value in southern California. For this purpose buds of a large number of varieties were obtained from Florida in 1906 and trees from these are now being grown for testing and distribution.

Tomatoes.—In certain sections of southern California a valuable industry exists in growing tomatoes for shipment during the late

fall and early winter. These are planted in the field in July and set a large amount of fruit during the latter part of the summer, which matures at a time when eastern tomatoes have been killed by frost. For this purpose varieties are desirable of good appearance and shipping quality, and also such as will continue to set fruit well into the winter. The variety most commonly planted at present, the Stone, is quite satisfactory for this purpose, but a number of other kinds are being tested at Whittier with the idea of obtaining the best variety for the exacting requirements of this shipping crop. Most of this work has been done with the assistance of Mr. R. E. Mansell, of the Experiment Station at Berkeley.

EUCALYPTUS INVESTIGATIONS.

A very careful study has been made under the direction of this Division by Mr. Ingham, of the Forestry Station, of the present condition, prospects and methods of Eucalyptus culture in California. The growth of these trees of many different species has been studied all over the State and their adaptation determined in the various sections. As a result of this study a bulletin has been prepared, entitled "Eucalyptus in California." This includes a discussion of the growing of Eucalyptus as a crop, the methods of the same, the utilization of the wood and descriptions of the important species. Following the preparation of this bulletin other work has been taken up upon the commercial utilization of Eucalyptus wood for lumber, its qualities, uses, methods of handling, etc. This has been taken up in a practical way by fitting up a small woodworking shop at the Santa Monica Station, where a great variety of samples is being prepared under Mr. Ingham's direction, showing the wood of the various species. These collections have been placed on exhibition and the work is being followed by further investigations along the same line.

Some work has also been done in the study of the extraction of oil from the foliage of various kinds of Eucalyptus. The oils obtained from the different species vary quite widely in their character.

WORK IN IMPERIAL VALLEY.

The great Imperial Valley region in the extreme southeastern part of California presents many serious problems in plant pathology as well as other lines of agricultural investigation. The rapid development of agriculture under the extremely unusual natural conditions of that region has been accompanied with many grave problems affecting the prosperity of the industry. As a result of this,

there has been a strong demand for a sub-station or some sort of local institution for agricultural investigation in that part of the State. In response to this demand the following Act was passed by the last legislature:

"An Act Making an Appropriation for the Investigation of Agricultural and Horticultural Problems and Conditions in Imperial County, and Providing for the Establishment in Said County of a Branch Agricultural Experiment Station for the Purpose of Prosecuting said work.

"The people of the State of California, represented in senate and assembly, do enact as follows:

"Section 1. The regents of the University of California are hereby directed to cause to be prosecuted, through the Southern California Pathological Laboratory and branch experiment station, investigations on the conditions and problems attending the culture of crops in the region known as the Imperial county and similar adjacent sections.

"Sec. 2. Such investigations shall be particularly directed toward the solution of various difficulties and problems affecting the growing of crops, which have arisen in said region on account of the unique natural conditions obtaining in that portion of the state.

"Sec. 3. The regents of the University of California are hereby authorized to establish at some suitable point in Imperial county a branch agricultural experiment station for the purpose of carrying on the work herein provided for; provided the necessary land therefor is obtained without cost to the state.

"Sec. 4. The sum of six thousand dollars ($6,000) is hereby appropriated out of any money in the state treasury not otherwise appropriated to be expended by the regents of the University of California in carrying out the purposes of this act, and the state controller is hereby authorized and directed to draw his warrant for the same payable to the regents of the University of California, and the treasurer of the state is hereby directed to pay such warrant."

Section 3, concerning the establishment of a station, constitutes a subsequent addition to the original bill and can hardly be complied with on the basis of the appropriation granted for this purpose. The original idea was that of conducting preliminary investigations and observations with these problems rather than establishing a permanent station at once. The work had not yet been organized at the close of the period covered by this report, but will be undertaken along whatever lines seem most suitable.

PASADENA CITY FARM.

An informal coöperative arrangement has been made by this Division during the past year with the city of Pasadena in regard to the development of a large tract of land owned by the city and used as a sewer farm. This land comprises over five hundred acres of varied and mostly excellent quality, and supports at present about one hundred acres of English walnuts and large crops of hay, grain,

corn and alfalfa. One of the greatest handicaps of this Division in southern California has been the lack of sufficient land for making plantings on a commercial scale of walnuts, citrus fruits, and various other crops in connection with which work is being done. The arrangement proposed by the city of Pasadena seems to fill this want in an almost ideal manner. The work can be done at practically no extra cost to the Experiment Station and can be made of value to Pasadena and other cities having sewage problems, in addition to the results that may be obtained from the regular lines of agricultural experimentation. Active work has already been begun on this project by planting a number of varieties of our walnuts for trial and grafting over of old trees. A citrus nursery has also been started and during the coming year a large amount of other nursery material will be planted on the farm.

PLANT DISEASES OF CALIFORNIA.

The following list contains a number of additional diseases to those given in our last report, as well as notes on the occurrence of the more serious troubles during the period covered. In general, the prevalence of plant diseases during the year 1907 was of about an average extent. The more common troubles occurred as extensively as usual, or on the whole rather more so. The year 1908 was marked by a very noteworthy freedom from fungous and bacterial plant diseases of all sorts. This evidently resulted from the dry winter of 1907-8 and the prevalence of dry, windy weather during much of the season all over the State. Thus the relation of climate to the occurrence of parasitic diseases was a most notable feature of the fruit season of 1908 in California. No general rule prevailed in 1909, some diseases being more abundant than usual and others noticeably absent.

POME FRUITS.

Apple.

Powdery Mildew.—This disease has proven an exception to the condition above stated, being more prevalent than usual during 1908. It is one of the serious troubles of the apple orchard in this State. Investigations on the control of the disease have been carried on to some extent by this Division, as reported elsewhere. Very prevalent in 1909.

Blight.—Attacks of the pear blight bacillus upon the apple occur to a limited extent, although no very serious results have occurred. The disease was prevalent to some extent on apples in 1908, although less in general than in previous years. Not commonly serious in 1909.

Canker (Nectria ditissima).—This fungous disease has been found in the State, but is not a serious trouble in commercial orchards.

"Baldwin Spot."—Troubles of this nature are becoming serious in California. In some sections the crop has been badly affected by the development of discolored spots or streaks in the interior of the apple from an unknown cause. No evidence is present of any parasitic attack.

Pear.

Scab.—Pear scab was extremely prevalent in 1907 and injured the quality of the crop greatly. Thorough spraying with Bordeaux mix-

ture, beginning when the buds first unfold and repeated later at intervals, showed excellent results as usual in controlling the disease. In 1908 and 1909 pear scab was almost entirely absent from the State.

Blight.—Pear blight prevailed to a considerable extent in 1907 and continued the destruction of many trees which began with the epidemic of 1904. In 1908 and 1909 the occurrence of the disease was very much reduced, and in many sections it disappeared almost entirely. This was due to climatic causes and does not indicate a permanent subsidence of the disease.

Curly Bark.—A very common but not serious condition of pear trees may be called by this name. It is shown by areas of bark which are cracked in a peculiar concentric manner, as the name indicates. Its occurrence is a matter of very little concern.

LOQUAT.

Scab.—The leaves and fruit are affected to considerable extent in the San Francisco Bay region by the fungus *Fusicladium eriobotryae*. Also found at Santa Barbara and Whittier in 1909.

STONE FRUITS.

APRICOT.

Dead Flower Buds.—A large acreage was badly affected in 1907 by a killing of the flower buds before opening, apparently by the peach blight fungus, *Coryneum*. Much less prevalent in the spring of 1908; more abundant in 1909.

Fruit Scab (*Cladosporium carpophilum*).—So far as known, this is the first record of Cladosporium spot on apricots. It is rather troublesome in some districts.

Fruit spot and shot-hole of leaf (*Coryneum*).—Quite serious on unsprayed trees.

ALMOND.

Shot-hole Fungus (*Cercospora circumscissa*).—This is of rather frequent occurrence, causing spotting of the leaves and twigs.

CHERRY.

Brown Rot (*Sclerotinia*).—Fruit and twigs of the cherry affected with the brown rot fungus were seen in the spring of 1908.

Gummosis.—Quite abundant in wet winters.

PEACH.

Leaf Curl and *California Blight.*—Were decidedly scarce in 1908. Both occurred to greater extent in the previous year. Leaf curl was very abundant in 1909; blight not very abundant.

Crown Gall.—Our most prevalent disease of stone fruit trees.

Root Rot (Toadstool or Oak Fungus).—Causing extensive losses in deciduous fruit orchards located on cleared oak land.

SMALL FRUITS.

Loganberry.

Rust (Puccinia peckiana).—Common.
Leaf Spot (Septoria rubi).—Common.
Root Knot.—Not uncommon.

SUBTROPICAL FRUITS.

Orange.

Scaly Bark.—This trouble consists in a rough breaking out of the bark on the trunk and branches of oranges, starting in a small area and greatly enlarging. It is a form of gum disease and cannot be connected with any parasite. The trouble is an old one in the State and is quite like that described in the Annual Report of the Florida Experiment Station for 1907.

Mal di gomma.—The typical form of this disease, as described from Florida and elsewhere as a rotting of the roots, is not of common occurrence in California, although a few bad cases have been seen.

Exanthema.—The disease described in Florida under this name occurs in southern California to a limited extent and almost entirely on one type of soil. This is the coarse, gravelly, very porous material, occurring close to the mountains in some sections. The trouble appears to be due to irregular nutrition, owing to the very loose nature of the soil. A few cases have been seen on heavier soils where excessive amounts of organic nitrogen have been applied. Experience appears to have demonstrated some benefit in this disease by spraying the trees with Bordeaux mixture. How this comes about is difficult to explain, except on the basis of an increased assimilation as an effect of the presence of the spray upon the leaves.

Splitting.—Considerable losses are experienced some years by a splitting of oranges before maturity. This affects particularly the Navels. It is evidently influenced by climatic conditions and is not the effect of a parasite. The trouble was very prevalent in the crop of 1907-08; much less abundant in 1908-09.

Brown Spot and *Staining.*—These troubles occurred to a serious extent during the winter of 1908. They are characterized by the

dying and discoloration of the surface of the rind in certain spots or areas, causing the disfiguration of the fruit. They were less abundant in 1909, except in certain sections.

Navel Rot (*Alternaria citri*).—This fungus causes considerable loss each year in Navel oranges by infection at the navel opening and the production of a black, dry rot. The fungus is not very active in its development, but spoils much fruit in wet winters. Affected fruit becomes prematurely ripe before the decay is visible externally.

Damping Off.—Much loss is caused in citrus seed beds by the killing of young plants by "damping off" fungi. This is caused most commonly by two parasites, one a species of *Fusarium* and the other *Rhizoctonia*. The development of these fungi is particularly favored by moisture and they can be controlled to a very large extent by judicious watering of the seed bed. In most cases the water is applied too frequently and abundantly and the spread of the fungus thus favored. This trouble was very abundant during the spring of 1909, when much cloudy weather occurred.

Anthracnose or "Tear Stain" (*Colletotrichum*).—This fungus seems to have been present in California for some time, but previous to 1909 has attracted no attention as affecting the fruit seriously, occurring only occasionally as a saprophyte on unhealthy leaves and twigs. During the past season, however, it has been quite abundant on oranges and extremely so on lemons and grapefruit in the coast sections.

LEMON.

Brown Rot (*Pythiacystis citrophthora*).—Less prevalent than usual in 1908 and 1909.

Cottony Mould Rot (*Sclerotinia*).—Not uncommon in curing houses.

Gray Mould (*Botrytis*).—Occurs occasionally in storage and sometimes causes considerable loss under cold storage conditions at low temperatures. Causes a brownish, soft rot of the rind, more or less covered with a considerable growth of loose gray mould.

Anthracnose or "Tear Stain" (*Colletotrichum*).—Quite common in coast sections in 1909, causing spots on the rind of the fruit. Infection apparently favored by attacks of red spider.

OLIVE.

Tuberculosis.—This bacterial disease is on the increase in certain sections and has become a matter of serious importance in those regions.

Leaf Spot (*Cycloconium oleaginum*).—Apparently rather common.

Dry Rot of fruit.—Cause unknown. Prevalent in 1908.

Guava.

Russeting.—An effect on the fruit in San Diego County.

VEGETABLES AND FIELD CROPS.

Asparagus.

Rust.—Continues to some extent each year. Damage by floods in the principal asparagus regions have somewhat overshadowed the effects of the rust. Much less abundant in 1908 and 1909.

Sugar Beet.

Rust (*Uromyces*).—The rust was extremely abundant during the winter of 1907-08 on sugar beets growing during the rainy season. It did not persist after the rains ceased.

Curly Top.—This disease, also called blight, occurred very little in 1907, but came on in some sections during the summer of 1908.

Downy Mildew (*Peronospora schachtii*).—Found in Los Angeles and Orange counties in the spring of 1909.

Root Rot (*Rhizoctonia*).—Caused considerable loss in young seedlings in 1908 and 1909.

Celery.

Leaf Blight.—This disease occurred disastrously in the large Orange County celery districts during the season of 1907-08. Great losses were experienced both in the field and in shipment. The disease was fully as prevalent during 1908-09, but was largely controlled in Orange County by spraying, as described on page 42.

Stem Rot (*Sclerotinia*).—Found in 1909. Not serious.

Root Rot (*Fusarium*).—Occurred only in extremely wet ground. Fungus possibly saprophytic.

Potato.

Early Blight (*Alternaria*).—Found in Berkeley and reported elsewhere. Not serious.

Late Blight (*Phytophthora*).—Occurs every year to a considerable extent on winter potatoes grown during the rainy season and on the summer crop in foggy sections along the coast.

Stem Rot (*Fusarium*).—Considerably abundant each year.

TOMATO.

Winter Blight (*Phytophthora infestans*).—Entirely ruined the late crop of shipping tomatoes in southern California in October, 1907. Less abundant in 1908.

Stem Rot (*Sclerotinia*) and *Nematode Root Rot*.—Observed on greenhouse plants in southern California.

Blossom End Rot.—Very prevalent in 1908. The origin of the disease appears to be connected with soil moisture conditions.

Summer Blight or *Wilt* (*Fusarium*).—Almost entirely absent from southern California in 1908, but quite abundant in the northern portion of the State. Apparently connected with *Fusarium* damping off in the seed bed. Soil in the field does not carry infection from year to year.

EGG PLANT.

Stem Blight (*Fusarium*).—A dry rot of the stem often starting above ground in infection through a wound. This plant grows to be two years old in California and infection by this disease is more common during the winter.

SWEET POTATO.

Black Rot (*Ceratocystis*).—Found in 1908 in Orange County for the first time in California.

Soft Rot (*Rhizopus*).—Quite common.

SWEET CORN.

Bacterial Disease (*Bacterium stewarti*).—An apparently typical case of this disease was found in southern California in 1909.

TURNIP.

Black Rot (*Bacterium campestre*).—A probable case found in 1909.

WATERMELON.

Wilt (*Fusarium*).—Abundant in old fields and growing worse.

GRAINS AND FORAGE CROPS.

ALFALFA.

Downy Mildew (*Peronospora trifoliorum*).—Found on one volunteer plant in 1909.

Alfalfa Crown Gall (*Urophlyctis alfalfae*).—This unusual disease was found in the State for the first time during 1909, and, so far as we know, has not been observed heretofore in this country. It has been collected in wet regions in Yolo and Stanislaus counties, and doubtless occurs elsewhere.

Fig. 23.—Crowngall of alfalfa.

NUT, FOREST AND SHADE TREES.

MADRONE.

Leaf Spot (*Sphaerella arbuticola*).—Quite abundant and disfiguring.

SYCAMORE.

Sycamore Blight (*Glocosporium nervisequum*).—Very prevalent in 1909.

PALM (*Washingtonia*).

Leaf Spot (*Auerswaldia sp.*).—Noticeable in parts of southern California.

WALNUT.

Bacteriosis.—Very prevalent in 1907. Less abundant in 1908 in most sections. Quite common in 1909.

BLUE GUM (*Eucalyptus*).

Leaf Spot (*Hendersonia sp.*).—Observed in several cases on young leaves.

FLORAL AND ORNAMENTAL.

CARNATION.

Leaf Spot (*Heterosporium*).—Rather common.
(*Septoria*).—Occasionally found.

OLEANDER.

Leaf Spot (*Macrosporium nerium*).—From Fresno.

SUNFLOWER.

Damping Off and *Stem Rot* (*Botrytis*).—Observed in one case.

ROSE.

Mildew, Rust and *Black Spot.*—All unusually abundant during the spring of 1909.

Station Publications Available for Distribution.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-03.
1904. Twenty-second Report of the Agricultural Experiment Station for 1903-04.

BULLETINS.

Reprint. Endurance of Drought in Soils of the Arid Region.
No. 128. Nature, Value and Utilization of Alkali Lands, and Tolerance of Alkali. (Revised and Reprint, 1905.)
133. Tolerance of Alkali by Various Cultures.
140. Lands of the Colorado Delta in Salton Basin, and Supplement.
142. Grasshoppers in California.
147. Culture Work of the Sub-stations.
149. California Sugar Industry.
150. The Value of Oak Leaves for Forage.
151. Arsenical Insecticides.
153. Spraying with Distillates.
154. Sulfur Sprays for Red Spider.
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159. Contribution to the Study of Fermentation.
160. The Hop Aphis.
161. Tuberculosis in Fowls. (Reprint.)
162. Commercial Fertilizers. (Dec. 1, 1904.)
163. Pear Scab.
165. Asparagus and Asparagus Rust in California.
167. Manufacture of Dry Wines in Hot Countries.
168. Observations on Some Vine Diseases in Sonoma County.
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174. A New Wine-cooling Machine.
176. Sugar Beets in the San Joaquin Valley.
177. A New Method of Making Dry Red Wine.
178. Mosquito Control.
179. Commercial Fertilizers. (June, 1906.)
180. Resistant Vineyards.
181. The Selection of Seed-Wheat.
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183. The California Tussock-moth.
184. Report of the Plant Pathologist to July 1, 1906.
185. Report of Progress in Cereal Investigations.
186. The Oidium of the Vine.
187. Commercial Fertilizers. (January, 1907.)
188. Lining of Ditches and Reservoirs to Prevent Seepage and Losses.
189. Commercial Fertilizers. (June, 1907.)
190. The Brown Rot of the Lemon.
191. California Peach Blight.
192. Insects Injurious to the Vine in California.
193. The Best Wine Grapes for California; Pruning Young Vines; Pruning the Sultanina.
194. Commercial Fertilizers. (Dec., 1907.)
195. The California Grape Root-worm.
197. Grape Culture in California; Improved Methods of Wine Making; Yeasts from California Grapes.
198. The Grape Leaf-Hopper.
199. The Bovine Tuberculosis.

CIRCULARS.

No. 1. Texas Fever.
2. Blackleg.
3. Hog Cholera.
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5. Contagious Abortion in Cows.
7. Remedies for Insects.
9. Asparagus Rust.
10. Reading Course in Economic Entomology. (Revision.)
11. Fumigation Practice.
12. Silk Culture.
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17. Why Agriculture Should be Taught in the Public Schools.
18. Caterpillars on Oaks.
19. Disinfection of Stables.
21. The Advancement of Agricultural Education.
24. Olive Pickling.
26. Selection and Preparation of Vine Cuttings.
27. Marly Subsoils and the Chlorosis or Yellowing of Citrus Trees.
28. A Preliminary Progress Report of Cereal Investigations, 1905-07.
29. Preliminary Announcement concerning Instruction in Practical Agriculture upon the University Farm, Davisville, Cal.
30. White Fly in California.
31. The Agricultural College and Its Relationship to the Scheme of National Education.
32. White Fly Eradication.
33. Packing Prunes in Cans. Cane Sugar vs. Beet Sugar.
34. California State Farmers' Institute at the University Farm.
35. Southern California Pathological Laboratory and Citrus Experiment Station.
36. Analyses of Fertilizers for Consumers.

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COMMERCIAL FERTILIZERS

By JOHN S. BURD

BULLETIN No. 205

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COMMERCIAL FERTILIZERS.

By JOHN S. BURD.

The present report contains the tabulated analyses of fertilizers collected for the half-year ending June 30, 1909. During this period 318 samples of fertilizers and fertilizing materials have been received at the laboratory. Of this number 39 were sent by farmers under the two-dollar fee provision, 189 were taken by inspectors from purchasers' goods upon the request of the purchasers, and 32 were taken by inspectors from goods in the hands of agents and manufacturers. On 37* samples the analysis as reported was used as a basis of settlement by mutual agreement of buyer and seller. No guaranty was required or given with goods sold under such an agreement. Fifty-eight samples of a miscellaneous nature are omitted from the tables.

The total number of samples handled is greater than that for any half-year yet reported. The percentages of purchasers' samples (73%) is also materially greater than heretofore. Indeed the attempts that have been made to comply with all reasonable requests from purchasers to sample their goods, has resulted in a considerable tax on the time of our inspectors. The superiority of such samples over those found in the hands of dealers, as indicating the character of the goods actually being delivered to consumers, justifies on the whole, the increased cost of inspection. It must be remembered, however, that lots of fertilizer at places remote from inspectors' headquarters cannot always be sampled. Requests to have inspectors sample purchases should be addressed to the Fertilizer Control, or for Southern California to Mr. A. C. Pickett, Riverside. In cases when such requests cannot be complied with, the consumer always has the privilege of taking his own sample and same will be analyzed if taken in accordance with our directions and accompanied by the nominal fee of $2.00, prescribed by law. No fee is required when samples are taken by our inspectors.

* Besides these a considerable number of the remaining purchasers' analyses were doubtless used subsequently as a basis of settlement, but without being reported to this office.

The following classification may be made of samples reported in this bulletin:

Complete Fertilizers	74
Bone Meal	23
Tankage	73
Superphosphate	8
Dried Blood	29
Nitrate of Soda	16
Sulfate of Potash	5
Bat guano	27
Bird guano phosphate	1
Ammoniated Superphosphate	2
Superphosphate and Potash	1
Muriate of Potash	1
Total	260

In connection with this classification it is perhaps worthy of note that complete fertilizers are not so well represented as in preceding reports. This may possibly be accounted for by an increased selling activity on the part of manufacturers of bone and tankage. It is to be hoped, however, that the greater use of materials, other than complete fertilizers, indicates an attempt on the part of the consumer to supply the fertilizer ingredients adapted to his particular crop and soil, rather than to follow the practice of adding all of the so-called "plant foods" in every case.

DEFICIENCIES.

In the analyses of the above samples, the following number of deficiencies greater than allowed by law occur:

Available phosphoric acid (total when available is not guaranteed)	30
Total nitrogen	29
Potash	13
In valuation	21

These deficiencies were found in 65 samples.

The fertilizer law allows a deficiency of 0.25 per cent in nitrogen, 0.50 per cent in potash, and 1.00 per cent in available phosphoric acid.

FERTILIZER VALUATIONS.

The calculations of the commercial values of the fertilizers here reported are made on the so-called unit basis. Such calculations consist simply in multiplying the number of per cent of each ingredient by the price per unit and adding the products. The sum thus obtained

is the commercial value per ton at the prices used. If it is desired to use such a calculation for determining the amount which should be paid for goods, or the rebate to which the buyer is entitled owing to the goods delivered being below the guaranty, it can only be satisfactorily done if a definite price per unit has been agreed upon between buyer and seller. But for the mere purpose of showing the relative values of goods to guaranties, it is not at all necessary that the prices adopted should be the exact market prices. Thus it is that the Fertilizer Control in attempting to show the relation between values found and values claimed, uses a schedule which is admittedly only an approximate average of market values. Owing to market fluctuations, differences in cost of delivery at different points, and other causes, the obtaining of true average market prices is an impossibility. But if the reader will bear in mind the true purpose of the valuations reported, these will have served their turn and he will not be led to assume that the Experiment Station is dictating the prices at which goods shall be sold.

SCHEDULE OF TRADE VALUES.

	Cents Per Pound.	Value Per unit.
Phosphoric Acid.		
Available (water and citrate-soluble)	6	$1 20
Insoluble in mixed fertilizers	2½	0 50
In fine* bone and tankage	4½	0 90
In medium* bone and tankage	3½	0 70
In fine* Thomas phosphate powder	5	1 00
In medium* Thomas phosphate powder	3	0 60
Nitrogen.		
In ammonia salts	18	3 60
In nitrates	17½	3 50
Organic in—		
Blood	21	4 20
Mixed fertilizers	20	4 00
Fine* bone and tankage	20½	4 10
Medium* bone and tankage	16	3 20
Potash.		
From sulfate	6	1 20
From muriate	5	1 00

* Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas phosphate powder by a 100-mesh sieve.

REPORT OF ANALYSES.*

Available phosphoric acid is not determined in bone meal, tankage, and Thomas phosphate powder, unless requested. The fineness of these materials is determined, fine and medium bone being separated by a sieve of 50 meshes to the inch; tankage by a 25-mesh sieve; and Thomas phosphate powder by a 100-mesh sieve.

Nitrogen in ammonia salts will, in some cases, be found reported when nitrogen in this form is not guaranteed. In some of such cases this form of nitrogen is produced by conversion of organic nitrogen during process of manufacture, and is not to be considered a deviation from guaranty of materials used. Guanos carry more or less nitrogen in nitrates and ammonia salts, and when any appreciable quantity of guano is used the manufacturer should take into account the fact that some nitrogen will show as nitrates and ammonia salts. The failure to take this into consideration may perhaps account for the appearance of these forms of nitrogen in some samples in which only organic nitrogen was guaranteed.

The percentage of chlorin is given when it exceeds 0.50 per cent. It is a matter of only technical interest whether chlorin present is from muriate of potash, kainit, or from common salt that may be in some of the materials used. If a manufacturer uses sulfate of potash and uses a tankage with it containing a large amount of chlorin, from a practical standpoint he has lowered the grade of his fertilizer just as much as if he had used muriate of potash instead of sulfate of potash. Chlorin from all other sources is as objectionable as from muriate of potash. However, if muriate of potash is found when sulfate is guaranteed, the fact will be published.

The following abbreviations are used in the tables: Bl=blood, Bn=bone, Fs=fish, G=guano, Super=superphosphate, T=tankage.

Guarantees are entered in *italics*. Deficiencies greater than allowed by law are entered in bold type.

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* The statement has sometimes been made that the work of the Fertilizer Control is being done by students. Such is not the case. All analyses are made by Messrs. P. L. McCreary and P. L. Hibbard, who are both careful and experienced analysts.

[See following pages for tables of analyses.]

ANALYSES AND VALUATIONS.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	Agricultural Chemical Works, Los Angeles, Cal.		
2097	Bat Guano	A. Bowring, Charter Oak	**23.85**
2098*	Bat Guano	A. Bowring, Charter Oak	**14.85**
2150	Bat Guano	J. E. Adamson, Pomona	34.73
	Guaranteed		*27.24*
2178	Bat Guano	A. H. Morgan, Rialto	25.62
	Guaranteed		*26.40*
2007	Bat Guano and Bone	A. L. Wright, Jr., Rialto	38.49
2030	Bat Guano and Bone	W. N. Glasscock, Rialto	37.55
	Guaranteed		*39.40*
2240	Bat Guano and Bone	L. S. Taylor, San Dimas	35.13
	Guaranteed		*37.20*
2103	Nitrate of Soda	T. W. Nisbet, Upland	53.72
2307	Nitrate of Soda	G. A. Herdeg, Riverside	54.25
	Guaranteed		*52.50*
2031	Special Orange and Lemon	A. P. Kitchen, Redlands	27.19
	Guaranteed		*26.60*
2032	Special Orange and Lemon	H. H. Pettit, Redlands	33.10
	Guaranteed		*34.90*
2082	Special Orange and Lemon	J. L. Showalter, Upland	27.49
	Guaranteed		*26.10*
2100	Special Orange and Lemon	L. E. Tyler, Upland	24.71
	Guaranteed		*23.40*
2172	Special Orange and Lemon	F. D. Hudson, Riverside	30.93
2174	Special Orange and Lemon	F. D. Hudson, Riverside	32.54
2241	Special Orange and Lemon	F. D. Hudson, Riverside	33.43
	Guaranteed		*31.70*
2173	Special Orange and Lemon	A. R. Ocheltree, Riverside	30.31
2190	Special Orange and Lemon	L. S. Taylor, San Dimas	29.05
	Guaranteed		*28.20*
2179	Special Orange and Lemon	F. D. Hudson, Riverside	29.37
	Guaranteed		*28.45*
2298	Special Orange and Lemon	G. A. Herdeg, Riverside	32.74
	Guaranteed		*30.45*
2306	Special Orange and Lemon	East Highlands Imp. Co., Ltd., Los A.	27.22
	Guaranteed		*26.60*
2101	Special Orange and Lemon	P. W. Tonnesen, Upland	27.55
	Guaranteed		*27.10*
2102	Special Orange and Lemon	Hollywood Grocery Co., Upland	30.01
	Guaranteed		*28.90*
	American Agricultural Chemical Co., Los Angeles, Cal.		
2222	Lawn	Graham Cope Com'l Co., Redlands	29.17
2099	Nursery Stock	W. A. Freemire, Ontario	30.18
	Guaranteed		*28.13*

*2098—22.5% rock. Drawn from one bag of lot represented by No. 2097.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID.				NITROGEN.					POTASH.			Chlorin.
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	
2097			2.48		1.35	0.36	3.65		**5.36**			1.03	
2098			1.64		1.01	0.29	2.02		**3.32**			0.74	
2150			4.92		2.75	1.55	3.90		8.20			1.42	
			2.40						*6.00*			*1.10*	
2178			2.81		1.43	0.38	3.90		5.71			1.17	
			2.60						*5.75*			*1.10*	
2007	7.50	5.32	12.84		2.38	1.85	2.64		6.87			1.07	
2030	7.26	5.45	12.71		0.82	0.87	4.70		**6.39**			1.09	
	6.00	*6.00*	*12.00*				*7.00*		*7.00*			*1.00*	
2240			10.72		3.22	0.38	3.10		**6.70**			1.26	
			10.00						*7.00*			*1.00*	
2103					15.35				15.35				
2307					15.50				15.50				
					15.00				*15.00*				
2031	5.02	4.68	9.70		1.66	0.10	2.28		4.04		2.95		
	5.00	*3.00*	*8.00*		*1.00*		*3.00*		*4.00*		*3.00*		
2032	5.28	3.65	8.93		2.04		3.78		5.82		2.23		
	5.00	*3.00*	*8.00*		*2.00*		*4.00*		*6.00*		*2.00*		
2082	4.93	4.13	9.06		1.41	0.60	2.16		4.17		3.14		
	5.00	*3.00*	*8.00*		*2.00*		*2.00*		*4.00*		*3.00*		
2100	7.12	4.72	11.84				1.88		1.88		5.24		
	7.00	*6.00*	*13.00*				*1.50*		*1.50*		*5.00*		
2172	4.81	5.01	9.82		3.02	0.20	2.67		5.89		**0.57**		
2174	4.87	4.49	9.36		2.99	0.20	2.68		5.87		2.12		
2241	6.30	2.53	8.83		3.12		2.77		5.89		2.17		
	4.00	*4.00*	*8.00*		*3.00*		*3.00*		*6.00*		*2.00*		
2173	4.36	4.52	8.88	Supr T	1.85	0.26	3.09	Bat G, Bl, Bn	5.10		2.54		
2190	4.00	4.68	8.68		2.49	0.14	2.45		5.08		2.41		
	4.00	*4.00*	*8.00*		*2.00*		*3.00*		*5.00*		*2.00*		
2179	4.34	4.78	9.12		2.46	0.15	2.45		5.06		2.35		
	4.00	*4.00*	*8.00*		*1.50*		*3.50*		*5.00*		*2.00*		
2298	7.21	4.61	11.82		2.60	0.15	2.45		5.03		1.96		
	4.00	*8.50*	*12.50*		*2.00*		*3.00*		*5.00*		*2.00*		
2306	6.42	4.30	10.72		2.70		1.33		4.03		2.17		
	6.00	*4.00*	*10.00*		*2.00*		*2.00*		*4.00*		*2.00*		
2101	6.42	4.91	11.33		1.15		2.70		3.85		2.14		
	6.00	*4.00*	*10.00*		*1.00*		*3.00*		*4.00*		*2.00*		
2102	5.58	3.53	9.11		2.79	0.20	2.06		5.05		2.35		
	5.00	*3.00*	*8.00*		*2.00*		*3.00*		*5.00*		*2.00*		
2222	9.33	0.94	10.27		2.55	0.65	1.05		4.25		1.71		
2099	9.08	1.79	10.87		2.62	0.70	1.13		4.45		1.81		
	9.00	*1.00*	*10.00*	Bn, Acid Phos	*2.35*	*0.50*	*1.25*	Bat G, Bl, Bn, T	*4.10*		*1.50*		

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	Armour Fertilizer Works, Los Angeles, Cal.		
2033	Blood	Chas. H. Low, Riverside	53.01
2070	Blood	Chas. H. Low, Riverside	52.48
2083	Blood	Azusa Foothills Citrus Assn., Azusa	54.61
2084	Blood	Azusa Foothills Citrus Assn., Azusa	55.23
2242	Blood	Azusa Foothills Citrus Assn., Azusa	52.48
2243*	Blood	Azusa Foothills Citrus Assn., Azusa	56.87
2244*	Blood	Azusa Foothills Citrus Assn., Azusa	49.61
2293	Blood	Chas. H. Low Riverside	57.07
	Sold on Station Analyses		
2044	Blood	Fitzgerald & Barry, Pasadena	60.14
2239	Blood	S. S. Garland, Redlands	58.84
2294	Blood	G. D. Whitcomb, Glendora	59.34
	Guaranteed		*58.80*
2205	Blood	Dr. H. H. Scott, Riverside	56.70
2235	Blood	Limoneira Co., Santa Paula	57.96
	Guaranteed		*57.75*
2034*	Bone Meal	Mrs. J. H. Simpson, Covina	38.86
	Guaranteed		*37.00*
2045*	Bone Meal	Fitzgerald & Barry, Pasadena	27.26
	Guaranteed		*28.55*
2056*	Bone Meal	W. C. Nickerson, Redlands	26.96
	Guaranteed		*27.10*
2085*	Bone Meal	Azusa Foothills Citrus Assn., Azusa	27.90
	Guaranteed		*28.65*
2236*	Bone Meal	Limoneira Co., Santa Paula	29.46
	Guaranteed		*27.10*
2238*	Bone Meal	S. S. Garland, Redlands	27.53
	Guaranteed		*27.40*
2245*	Bone Meal	Azusa Foothills Citrus Assn., Azusa	28.15
	Guaranteed		*28.90*
2143	Lawn and Garden	H. P. Greene, San Diego	24.31
	Guaranteed		*25.35*
2299	Orange Tree Manure	Fred A. Browne, Pomona	25.82
2308	Orange Tree Manure	L. C. Waite, Riverside	27.54
	Guaranteed		*26.72*
2046	Special	G. J. Ambrose, Covina	34.66
	Guaranteed		*34.00*
2047	Special 5-8-2	E. O. Thomason, Covina	28.77
	Guaranteed		*28.25*
2048	Special	E. F. Badger, Azusa	38.30
	Guaranteed		*38.52*
2095	Special	C. O. Buller, Covina	47.22
	Guaranteed		*45.00*
2181	Special	H. Stephenson, Riverside	37.20
	Guaranteed		*37.55*
2049	Sulfate of Potash	Fitzgerald & Barry, Pasadena	60.48
	Guaranteed		*57.60*
2142	Sulfate of Potash	C. C. Chapman, Fullerton	59.54
	Guaranteed		*58.00*
2279*	Tankage	A. D. Bell, Colton	38.85
	Guaranteed		*34.50*

*2243—Some hoof.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	POUNDS PER HUNDRED.												
	PHOSPHORIC ACID.				NITROGEN.					POTASH.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2033	.....	.....	.....	.....	.....	.....	12.93	.....	12.93	.....	.....	.....	.....
2070	.....	.....	.....	.....	.....	.....	12.80	.....	12.80	.....	.....	.....	.....
2083	.....	.....	.....	.....	.....	.....	13.32	.....	13.32	.....	.....	.....	.....
2084	.....	.....	.....	.....	.....	.....	13.47	.....	13.47	.....	.....	.....	.....
2242	.....	.....	.....	.....	.....	.....	12.80	.....	12.80	.....	.....	.....	.....
2243	.....	.....	.....	.....	.....	.....	13.87	.....	13.87	.....	.....	.....	.....
2244	.....	.....	.....	.....	.....	.....	12.10	.....	12.10	.....	.....	.....	.....
2293	.....	.....	.....	.....	.....	.....	13.92	.....	13.92	.....	.....	.....	.....
2044	.....	.....	.....	.....	.....	.....	14.32	.....	14.32	.....	.....	.....	.....
2239	.....	.....	.....	.....	.....	.....	14.01	.....	14.01	.....	.....	.....	.....
2294	.....	.....	.....	.....	.....	.....	14.13	.....	14.13	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*14.00*	.....	*14.00*	.....	.....	.....	.....
2205	.....	.....	.....	.....	.....	.....	13.50	.....	13.50	.....	.....	.....	.....
2235	.....	.....	.....	.....	.....	.....	13.80	.....	13.80	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.75*	.....	*13.75*	.....	.....	.....	.....
2034	.....	.....	24.32	.....	.....	.....	2.50	.....	2.50	.....	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....	.....
2045	.....	.....	**21.12**	.....	.....	.....	2.77	.....	2.77	.....	.....	.....	.....
.....	.....	.....	*24.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....	.....
2056	.....	.....	22.16	.....	.....	.....	2.43	.....	2.43	.....	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....	.....
2085	.....	.....	**22.64**	.....	.....	.....	2.59	.....	2.59	.....	.....	.....	.....
.....	.....	.....	*24.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....	.....
2236	.....	.....	23.48	.....	.....	.....	2.81	.....	2.81	.....	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....	.....
2238	.....	.....	21.90	.....	.....	.....	2.62	.....	2.62	.....	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....	.....
2245	.....	.....	**22.36**	.....	.....	.....	2.73	.....	2.73	.....	.....	.....	.....
.....	.....	.....	*24.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....	.....
2143	4.33	1.11	5.44		1.55	0.10	2.03		**3.68**	.....	3.88	.....	0.70
.....	*4.00*	*1.00*	*5.00*		*1.50*	.....	*2.50*		*4.00*	.....	*4.00*	.....	.....
2299	7.23	3.33	10.56		0.99	0.55	1.30		2.84	.....	4.02	.....	0.67
2308	7.47	2.74	10.21	Bn,	1.04	0.90	1.35		3.29	.....	4.11	.....	.....
.....	*8.00*	*2.00*	*10.00*	G,	*0.75*	*0.75*	*1.50*	Bl, Bn,	*3.00*	.....	*4.00*	.....	.....
2046	.....	.....	12.20	Supr	.....	.....	4.79	G., T.	4.79	.....	4.78	.....	.....
.....	.....	.....	*10.00*		.....	.....	*5.00*		*5.00*	.....	*5.00*	.....	.....
2047	7.81	2.04	9.85		1.87	.....	2.27		4.14	.....	2.29	.....	.....
.....	*8.00*	*2.00*	*10.00*		*1.50*	.....	*2.50*		*4.00*	.....	*2.00*	.....	.....
2048	.....	.....	13.33	.....	.....	0.80	4.73	.....	5.53	.....	4.87	.....	.....
.....	.....	.....	*12.70*	Bn, Super	.....	*1.00*	*4.75*	Bl, Bn, T	*5.75*	.....	*4.80*	.....	.....
2095	.....	.....	5.41	.....	2.62	3.55	4.68	.....	10.85	.....	1.86	.....	1.08
.....	.....	.....	*5.00*	Bn, G, Super	.....	*2.00*	*8.00*	Bl, Bn, G, T	*10.00*	.....	*1.50*	.....	.....
2181	.....	.....	11.84	.....	2.43	0.22	3.12	.....	5.77	.....	4.97	.....	0.70
.....	.....	.....	*12.50*	Bn	*2.50*	.....	*3.50*	Bl, Bn, T	*6.00*	.....	*4.00*	.....	.....
2049	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.40	.....	1.07
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*48.00*	.....	.....
2142	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.20	.....	2.26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*48.67*	.....	.....
2279	.....	.....	8.39	.....	.....	.....	8.20	.....	8.20	.....	.....	.....	.....
.....	.....	.....	*4.50*	.....	.....	.....	*8.00*	.....	*8.00*	.....	.....	.....	.....

*2236—66% fine. Some hoof.
*2238—69% fine. Some hoof.
*2279—81% fine. Some hoof and hair.
*2205—73% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	California Fertilizer Works, San Francisco, Cal.		
2292	Blood	Hanson & Seares, Uplands	**45.90**
	Guaranteed		*48.42*
2282*	Bone Meal	Hanson & Seares, Upland	25.13
	Guaranteed		*25.40*
2006*	Blood and Bone	E. P. Wright, Duarte	33.30
	Guaranteed		*33.01*
2096	Fruit, Orange and Vine	Hayward Reed, Sacramento	27.53
	Guaranteed		*27.10*
2029	High Grade Bone and Blood Superphosphate	H. Postlethwaite, San Jose	35.26
	Guaranteed		*32.00*
2285*	High Grade Bone and Blood Superphosphate	Hanson & Seares, Upland	31.93
	Guaranteed		*33.70*
2288*	High Grade Bone and Blood Superphosphate	H. Postlethwaite, San Jose	33.53
	Guaranteed		*33.46*
2028	Fruit, Orange and Vine	H. Postlethwaite, San Jose	26.52
	Guaranteed		*27.10*
2167	Nitrate of Soda	A. W. Handyside, Duarte	54.53
	Guaranteed		*54.84*
2277	Nitrate of Soda	J. Knapp, Upland	54.95
	Guaranteed		*52.50*
2123	Special	H. Postlethwaite, San Jose	38.18
	Guaranteed		*33.22*
2270	Special A	Silva & Bergtholdt Co., Newcastle	31.32
	Guaranteed		*30.95*
2272	Special C	Silva & Bergtholdt Co., Newcastle	27.65
	Guaranteed		*28.24*
2271	Special D	Silva & Bergtholdt Co., Newcastle	24.93
	Guaranteed		*26.40*
2169*	Special Bone, Blood and Potash	A. B. Downe, Duarte	**30.60**
	Guaranteed		*35.00*
2202	Special High Grade Fertilizer	Vosburg & Williams, Porterville	34.34
2265	Special High Grade Fertilizer	Vosburg & Williams, Porterville	30.73
2286	Special High Grade Fertilizer	Hanson & Seares, Upland	31.46
	Guaranteed		*29.95*
2027	Special Lemon Fertilizer	H. Postlethwaite, San Jose	27.70
	Guaranteed		*26.58*
2246	Special Nursery Stock	F. D. Hudson, Riverside	27.21
2319	Special Nursery Stock	F. D. Hudson, Riverside	27.70
	Guaranteed		*27.80*
2170	Special Orange A	A. W. Handyside, Duarte	27.64
2287	Special Orange A	Hanson & Seares, Upland	32.06
	Guaranteed		*27.85*
2223	Special Orange and Lemon	A. B. Hill, Pomona	26.51
	Guaranteed		*26.95*

*2282—62% fine.
*2006—60% fine.
*2285—Some hoof.
*2288—Some hoof.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2292							10.93		**10.93**				
							11.53		*11.53*				
2282			20.14				2.40		2.40				
			20.00				*2.50*		*2.50*				
2006			22.00				4.20		4.20				
			22.00	Bn			*4.12*	Bl, Bn	*4.12*				
2096	7.10	2.21	9.31		0.59	0.50	1.34		2.43		7.24		0.82
	6.00	*3.50*	*9.50*	Bn. Super.	*0.50*		*2.00*	Animal Matter	*2.50*		*7.00*		
2029	**10.33**	8.04	18.37		0.33	1.85	2.76		4.94				
	12.00	*4.00*	*16.00*				*3.90*		*3.90*				
2285	12.68	3.82	16.50	Bn			3.70	Bl,	3.70				
	13.00	*5.00*	*18.00*	Supr			*3.90*	Bn	*3.90*				
2288	11.18	3.70	14.88				3.90		3.90		2.22		
	9.00	*6.00*	*15.00*				*4.10*		*4.10*		*2.00*		
2028	7.04	1.86	8.90		0.47	0.45	1.22		**2.14**		7.49		0.87
	6.00	*3.50*	*9.50*	Bn, Super	*0.50*		*2.00*	Bl, Bn, T.	*2.50*		*7.00*		
2167					15.58				15.58				
					15.67				*15.67*				
2277					15.70				15.70				
					15.00				*15.00*				
2123	6.83	7.35	14.18		0.77	0.56	2.10		3.43		11.00		0.95
	5.00	*8.00*	*13.00*		*0.35*		*2.50*		*2.85*		*10.00*		
2270			9.39	Bn,	1.28	3.04	0.70	Bl,	5.02		4.66		0.60
			10.00	Supr	*1.23*	*2.48*	*1.23*	Bn	*4.94*		*4.00*		
2272			9.17				1.95		1.95		10.44		0.90
			10.00				*2.06*		*2.06*		*10.00*		
2271	12.08	0.91	13.09								8.70		
	13.00										*9.00*		
2169	**6.02**	3.48	9.50		0.83	0.60	1.12		**2.55**		10.07		
	8.00	*2.00*	*10.00*				*4.00*		*4.00*		*7.00*		
2202	5.13	4.17	9.30	Bn,	1.55	0.71	1.42	B ,	3.68		10.37		1.00
2265	5.47	3.84	9.31	Supr	0.45	0.71	1.44	Bn	2.60		10.29		0.95
2286	7.38	3.44	10.82		1.38	0.50	2.22		4.10		**4.48**		
	6.00	*2.00*	*8.00*		*0.50*		*2.00*		*2.50*		*10.00*		
2027			11.25		0.11	0.22	2.36		2.69		6.74		0.80
			10.00	Bn			*2.50*	Bl, Bn	*2.50*		*7.15*		
2246	**4.75**	6.66	11.41		1.24	0.84	2.00		4.08		2.35		0.60
2319	6.82	3.55	10.37		1.02	0.48	2.40		3.90		2.37		0.62
	7.00	*3.00*	*10.00*	Bn, Super	*1.00*		*3.00*	Animal Matter	*4.00*		*2.00*		
2170	4.57	3.75	8.32			0.89	0.91		1.80		**11.19**		
2287	6.15	2.53	8.68			0.68	1.22		1.90		13.40		0.97
	5.00	*2.50*	*7.50*	Super		*0.50*	*1.19*	Animal Matter	*1.60*		*12.00*		
2223	5.54	4.92	10.46		0.97	0.62	1.45		3.04		4.99		0.70
	6.00	*4.00*	*10.00*	Bn, Super	*0.50*		*2.50*	Animal Matter	*3.00*		*5.00*		

*2169—Discrepancy between guaranty and analysis, claimed by manufacturer to be due to error in tagging.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	California Fertilizer Works—Continued.		
2171	Special Orange Tree	A. W. Handyside, Duarte	26.52
2206	Special Orange Tree	Mrs. C. E. White, Pomona	27.45
2284	Special Orange Tree	D. F. Bremner, Upland	28.45
	Guaranteed		*27.35*
	Cudahy Packing Co., South Omaha, Neb.		
2207*	Blood and Bone	C. C. Brown, Redlands	32.82
	Guaranteed		*32.86*
2224*	Blood and Bone	Dr. C. J. Creighton, Redlands	32.27
	Guaranteed		*32.65*
2225*	Blood and Bone	J. H. Reynolds, Redlands	31.87
	Guaranteed		*33.40*
2291*	Blood and Bone	E. B. Clark, Upland	31.80
	Guaranteed		*34.08*
2220*	Tankage	J. H. McCulloch, Chula Vista	32.00
	Guaranteed		*31.88*
	Hauser Packing Co. Los Angeles, Cal.		
2107	Blood	M. M. Seabolt, Los Angeles	**48.72**
	Guaranteed		*50.40*
2109*	Bone Meal	M. M. Seabolt, Los Angeles	31.64
	Guaranteed		*23.58*
2050*	Tankage	A. P. Collins, Riverside	32.66
	Sold on Station Analyses		
2057*	Tankage	Chas. Silent, Los Angeles	30.01
	Guaranteed		*28.92*
2058*	Tankage	Chas. Silent, Los Angeles	31.79
	Guaranteed		*32.64*
2104*	Tankage (Old)	M. M. Seabolt, Los Angeles	14.60
	Guaranteed		*5.20*
2105*	Tankage	M. M. Seabolt, Los Angeles	29.91
	Guaranteed		*28.20*
2106*	Tankage	M. M. Seabolt, Los Angeles	32.48
	Guaranteed		*32.50*
2108*	Tankage (Dust)	M. M. Seabolt, Los Angeles	36.39
	Guaranteed		*34.11*
2151	Tankage	Hugh Latimer, Arlington	29.53
	Guaranteed		*29.05*
2165	Tankage	Hugh Latimer, Arlington	31.91
	Sold on Station Analyses		
2166*	Tankage	Hugh Latimer, Arlington	33.33
	Guaranteed		*34.25*
2175	Tankage	Mrs. N. J. Levinson, Colton	32.56
	Guaranteed		*[illegible]*

2207—79% fine. Some hoof.
*2224—74% fine.
2225—88% fine.
2291—83% fine. Some hoof.

*2220—90% fine. Some hoof.
*2109—42% fine.
*2050—77% fine.
*2057—52% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.												
	Phosphoric Acid.			Nitrogen.					Potash.				
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2171	5.04	5.27	10.31		0.42	0.68	1.26		2.36		7.40		
2206	6.05	3.29	9.34		0.71	0.40	1.52		2.63		7.12		0.67
2284	5.88	4.08	9.96		0.55	0.22	2.04		2.81		7.06		0.77
	6.00	*3.50*	*9.50*	Super	*0.25*		*2.25*	Animal Matter	*2.50*		*7.40*		
2207	6.62	9.20	15.82				5.20		5.20				
	7.50	*6.00*	*13.50*				*5.35*		*5.35*				
2224	6.10	10.21	16.31				5.14		5.14				
	7.50	*6.00*	*13.50*				*5.35*		*5.35*				
2225	4.00	6.05	10.05	Bn			6.01	Bl. Bn	6.01				
	7.50	*6.00*	*13.50*				*5.35*		*5.35*				
2291	3.34	5.79	9.13				6.32		6.32				
	7.50	*6.00*	*13.50*				*5.35*		*5.35*				
2220			12.30				5.54		5.54				
			13.05				*5.36*		*5.36*				
2107							11.60		11.60				
							12.00		*12.00*				
2109			31.40				1.82		1.82				
			25.00				*1.00*		*1.00*				
2050			19.04				4.47		4.47				
2057			15.58				4.67		4.67				
			15.00				*4.50*		*4.50*				
2058			12.10				5.76		5.76				
			12.00				*6.00*		*6.00*				
2104			6.15				2.69		2.69				
			2.00				*1.00*		*1.00*				
2105			15.66				4.83		4.83				
			15.00				*4.50*		*4.50*				
2106			12.76				5.77		5.77				
			12.35				*5.86*		*5.86*				
2108			16.09				5.85		5.85				
			15.00				*5.50*		*5.50*				
2151			15.96				4.53		4.53				
			15.00				*4.61*		*4.61*				
2165			12.20				5.83		5.83				
2166			14.47				6.11		6.11				
			15.00				*6.25*		*6.25*				
2175			18.16				4.72		4.72				
			19.00				*4.50*		*4.50*				

*2058—72% fine. *2106—73% fine. *2165—66% fine.
*2104—45% fine. *2108—98% fine. *2166—40% fine.
*2105—46% fine. *2151—55% fine. *2175—70% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	Hawaiian Fertilizer Co., San Francisco, Cal.		
2183	Nitrate of Soda	Mohnicke & Sons, Chula Vista	**53.16**
	Guaranteed		*54.25*
2203	Superphosphate	Koerbel Bros., Guerneville	21.08
	Guaranteed		*20.78*
	Simon Levy, Los Angeles, Cal.		
2136*	Tankage	J. J. Atwood, Upland	**19.57**
	Guaranteed		*31.70*
	Thomas Lewis, Sacramento, Cal.		
2322	Tom Lewis Fertilizer	Thomas Lewis, Sacramento	4.95
	Guaranteed		*5.40*
	Los Angeles Fertilizer Co., Los Angeles, Cal.		
2247*	Bone Meal	E. F. Wilson, Upland	30.75
	Guaranteed		*30.93*
2250	Hanson's Odorless Lawn	E. F. Wilson, Upland	25.04
	Guaranteed		*27.45*
2248*	Los Angeles Fruit Grower	E. F. Wilson, Upland	23.33
	Guaranteed		*23.18*
2251	Los Ang's Special Fruit Grower	D. F. Bemner, Upland	**27.36**
	Guaranteed		*30.60*
2249	Nitrate of Soda	E. F. Wilson, Upland	53.97
	Guaranteed		*52.50*
2278*	Tankage	E. F. Wilson, Upland	32.10
	Guaranteed		*33.12*
	Mapes Formula and Peruvian Guano Co., New York, N.Y.		
2110	Orange Tree Manure	J. J. Prendergast, Redlands	27.97
	Guaranteed		*23.70*
	Morris & Co., Chicago, Ill.		
2152	Blood	Chas. Kidd, Highgrove	58.97
2184	Blood	Leffingwell Rancho, Whittier	58.59
	Guaranteed		*58.80*
2111*	Pacific Big 2	R. H. Jones, Hollywood	32.18
	Guaranteed		*32.05*
2124*	Pacific Big 2	R. H. Jones, Hollywood	33.36
2125*	Pacific Big 2	R. H. Jones, Hollywood	32.54
	Sold on Station Analyses		
2185*	Pacific Big 2	Leffingwell Rancho, Whittier	31.30
	Guaranteed		*32.00*

*2136—67% fine.
*2247—42% fine. Some hoof.
*2248—Some hoof.
*2278—71% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2183	....	....	....	....	15.19	....	....	....	15.19	....	....	....	....
....	....	....	....	....	*15.50*	....	....	....	*15.50*	....	....	....	....
2203	17.57	0.55	18.12	....	....	....	....	....	....	....	....	....	....
....	*17.32*	....	....	....	....	....	....	....	....	....	....	....	....
2136	....	....	**9.16**	....	....	....	3.22	....	**3.22**	....	....	....	....
....	....	....	*15.55*	....	....	....	*5.07*	....	*5.07*	....	....	....	....
2322	....	....	1.57	....	....	....	....	....	0.84	....	....	0.27	....
....	....	....	*1.63*	Fs, night soil	....	....	....	Fs, night soil	*0.96*	....	....	*0.21*	....
2247	....	....	**21.52**	....	....	....	3.78	....	3.78	....	....	....	....
....	....	....	*23.00*	....	....	....	*3.50*	....	*3.50*	....	....	....	....
2250	7.53	0.83	8.36	....	3.50	....	....	....	**3.50**	....	2.76	....	0.62
....	*8.00*	*0.50*	*8.50*	Super	*4.00*	....	....	....	*4.00*	....	*3.00*	....	....
2248	5.09	5.88	10.97	....	1.29	0.12	1.35	....	2.76	....	3.28	....	....
....	*6.00*	*2.00*	*8.00*	Bn, T, Super	*0.75*	*0.60*	*1.65*	Bl, Bn, T	*3.00*	....	*3.00*	....	....
2251	**5.93**	4.48	10.41	....	2.14	0.15	1.48	....	3.77	....	**3.38**	....	0.87
....	*8.00*	*2.00*	*10.00*	Bn, T, Super	*1.00*	*0.75*	*2.25*	Bl, Bn, T	*4.00*	....	*4.00*	....	....
2249	....	....	....	....	15.42	....	....	....	15.42	....	....	....	....
....	....	....	....	....	*15.00*	....	....	....	*15.00*	....	....	....	....
2278	....	....	14.83	....	....	....	5.27	....	**5.27**	....	....	....	....
....	....	....	*13.75*	....	....	....	*5.76*	....	*5.76*	....	....	....	....
2110	7.12	2.93	10 05	....	0.95	2.07	0.65	....	3.67	....	3.81	....	....
....	*6.00*	*2.00*	*8.00*	Bn, G	*2.40*	*0.15*	*0.74*	G	*3.29*	....	*3.00*	....	....
2152	....	....	....	....	....	....	14.04	....	14.04	....	....	....	....
2184	....	....	....	....	....	....	13.95	....	13.95	....	....	....	....
....	....	....	....	....	....	....	*14.00*	....	*14.00*	....	....	....	....
2111	....	....	**25.36**	....	....	....	3.08	....	3.08	....	....	....	....
....	....	....	*28.00*	Bn	....	....	*2.50*	Bn	*2.50*	....	....	....	....
2124	....	....	25.70	....	....	....	3.25	....	3.25	....	....	....	....
2125	....	....	25.18	....	....	....	3.00	....	3.00	....	....	....	....
2185	....	....	**25.44**	....	....	....	2.85	....	2.85	....	....	....	....
....	....	....	*28.00*	Bn	....	....	*2.50*	Bn	*2.50*	....	....	....	....

*2124—82% fine.
*2125—66% fine.

*2111—74% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices
	Morris & Co., Chicago, Ill.—Continued.		
2252*	Pacific Big 2	Sargent Bros., Whittier	29.04
	Guaranteed		*31.75*
2309*	Pacific Big 2	B. K. Brant, Upland	33.13
	Guaranteed		*31.98*
2313*	Pacific Big 2	B. K. Brant, Upland	33.92
	Guaranteed		*31.98*
2024*	Pacific Big 4	Frank L. Palmer, Pomona	44.23
2025*	Pacific Big 4	Frank L. Palmer, Pomona	44.27
	Guaranteed		*43.41*
2075*	Pacific Big 4	A. S. Bradford, Fullerton	44.53
	Guaranteed		*43.60*
2076*	Pacific Big 4	C. C. Chapman, Fullerton	43.87
	Guaranteed		*43.40*
2086*	Pacific Big 4	Brearly Investment Co., Los Angeles.	41.80
	Sold on Station Analyses		
2112*	Pacific Big 4	P. J. Gilhooly, Los Angeles	43.43
2113*	Pacific Big 4	P. J. Gilhooly, Los Angeles	44.27
	Guaranteed		*43.40*
2114*	Pacific Big 4	R. H. Jones, Hollywood	43.99
	Guaranteed		*43.74*
2144*	Pacific Big 4	Sweetwater Fruit Co., Bonita	43.39
2145*	Pacific Big 4	Sweetwater Fruit Co., Bonita	42.96
2146*	Pacific Big 4	San Diego L. & T. Co., Chula Vista	43.10
	Guaranteed		*43.20*
2147*	Pacific Big 4	W. H. Robinson, Riverside	43.02
	Guaranteed		*43.60*
2148*	Pacific Big 4	F. T. Morrison, Riverside	41.58
	Guaranteed		*43.40*
2153*	Pacific Big 4	Wright Bros., Riverside	43.10
	Guaranteed		*42.93*
2154*	Pacific Big 4	F. H. Speich Co., Riverside	43.46
	Guaranteed		*43.33*
2155*	Pacific Big 4	John Norton, Riverside	44.94
	Guaranteed		*43.60*
2156*	Pacific Big 4	Mrs. W. A. Fox, Colton	42.90
	Guaranteed		*43.20*
2157*	Pacific Big 4	E. D. Roberts, San Bernardino	43.57
	Guaranteed		*43.40*
2163*	Pacific Big 4	Major E. F. C. Klokke, Los Angeles.	42.35
	Guaranteed		*42.73*
2226*	Pacific Big 4	C. K. Alley, Los Angeles	41.13
	Guaranteed		*42.34*
2253*	Pacific Big 4	Sargent Bros., Whittier	43.76
	Guaranteed		*43.33*
2296*	Pacific Big 4	Rev. E. F. Goff, Claremont	42.56
	Guaranteed		*42.34*

*2185—71% fine.
*2252—60% fine.
*2309—75% fine.
*2313—72% fine.
*2024—82% fine. Some hoof.
*2025—83% fine. Some hoof.

*2075—84% fine. Considerable hoof.
*2076—82% fine. Considerable hoof.
*2086—83% fine. Some hoof.
*2112—83% fine.
*2113—83% fine.
*2114—86% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.													
	Phosphoric Acid.				Nitrogen.					Potash.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2252			**24.70**				2.48		2.48				
			28.00	Bn			*2.50*	Bn	*2.50*				
2309			27.10				2.95		2.95				
			28.00	Bn			*2.47*	Bn	*2.47*				
2313			27.12				3.15		3.15				
			28.00	Bn			*2.47*	Bn	*2.47*				
2024			5.41				10.13		10.13				
2025			5.51				10.12		10.12				
			5.50	T			*9.90*	T	*9.90*				
2075			5.91				10.05		10.05				
			5.50	T			*9.90*	T	*9.90*				
2076			6.48				9.82		9.82				
			5.50	T			*9.90*	T	*9.90*				
2086			4.68				9.66		9.66				
2112			6.23				9.76		9.76				
2113			6.09				10.00		10.00				
			5.50	T			*9.90*	T	*9.90*				
2114			5.97				9.85		9.85				
			5.50	T			*9.88*	T	*9.88*				
2144			5.74				9.90		9.90				
2145			5.84				9.77		9.77				
2146			4.98				9.98		9.98				
			5.50	T			*9.90*	T	*9.90*				
2147			4.57				9.94		9.94				
			5.50	T			*9.90*	T	*9.90*				
2148			4.95				9.55		**9.55**				
			5.50	T			*9.90*	T	*9.90*				
2153			5.52				9.92		9.92				
			5.50	T			*9.88*	T	*9.88*				
2154			5.17				9.98		9.98				
			5.50	T			*9.88*	T	*9.88*				
2155			5.84				10.17		10.17				
			5.50	T			*9.90*	T	*9.90*				
2156			6.02				9.72		9.72				
			5.50	T			*9.90*	T	*9.90*				
2157			6.25				9.79		9.79				
			5.50	T			*9.90*	T	*9.90*				
2163			5.33				9.82		9.82				
			5.50	T			*9.88*	T	*9.88*				
2226			4.92				9.69		9.69				
			5.50	T			*9.88*	T	*9.88*				
2253			5.91				9.91		9.91				
			5.50	T			*9.88*	T	*9.88*				
2296			6.01				9.83		9.83				
			5.50	T			*9.88*	T	*9.88*				

*2144—80% fine.
*2145—80% fine.
*2146—80% fine.
*2147—85% fine.
*2148—83% fine.
*2153—78% fine.
*2154—83% fine.
*2155—84% fine.
*2156—81% fine.
*2157—82% fine.
*2163—75% fine.
*2226—72% fine. Some hoof.
*2253—82% fine. Some hoof.
*2296—72% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	Morris & Co., Chicago, Ill.—Continued.		
2192*	Pacific Big 7	W. J. Wallace, Riverside	39.19
	Guaranteed		*39.23*
2208*	Pacific Big 7	David McClelland, Redlands	41.42
	Guaranteed		*38.66*
	Mountain Copper Co., San Francisco, Cal.		
2227	Mixed	H. J. Nichols, Pomona	33.49
	Guaranteed		*31.72*
2158	Superphosphate	G. R. Moore, Pomona	22.11
2159	Superphosphate	H. F. McGowan, Pomona	22.27
	Guaranteed		*21.74*
2237	Superphosphate	Limoneira Co., Santa Paula	22.83
2303	Superphosphate	Sparr Fruit Co., Los Angeles	22.17
	Guaranteed		*21.95*
	Mutual Orange Distributors, Redlands, Cal.		
2053*	Bone Meal	Redlands Mutual Orange Co., Redlands	32.18
	Guaranteed		*32.96*
2255	Mutual Special	Factory, Redlands	40.25
	Guaranteed		*39.40*
2305	Mutual Spring	Redlands Mutual Orange Co., Redlands	33.70
	Guaranteed		*31.30*
2126	Nitrate of Soda	W. O. Roice, Colton	53.76
2254	Nitrate of Soda	Wm. Preston, Redlands	53.76
	Guaranteed		*52.50*
2256	Special	Factory, Redlands	36.35
	Guaranteed		*37.45*
2023*	Tankage	E. Highlands Citrus Assn., E. Highlands	34.54
	Guaranteed		*29.80*
2043*	Tankage	A. B. Cowgill, Redlands	38.99
	Guaranteed		*36.48*
2052*	Tankage	E. Highlands Citrus Assn., E. Highlands	34.28
	Guaranteed		*31.52*
2054*	Tankage	Redlands Mutual Orange Co., Redlands	34.98
	Guaranteed		*37.20*
2068*	Tankage	J. W. Corwin, Highlands	35.69
	Guaranteed		*31.73*
2164*	Tankage	J. H. Strait, Redlands	36.58
	Guaranteed		*36.89*
2176*	Tankage	Mrs. N. J. Levinson, Colton	31.24
	Guaranteed		*29.67*
2193*	Tankage	L. C. Waite, Riverside	29.60
	Guaranteed		*39.87*
2257*	Tankage	Factory, Redlands	40.27
	Guaranteed		*41.25*
2055	Whale Blood and Meat	Redlands Mutual Orange Co., Redlands	42.08
	Guaranteed		*40.00*

*2192—87% fine.
*2208—80% fine. Some hoof.

*2053—21% fine.
*2023—76% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	POUNDS PER HUNDRED.											
	PHOSPHORIC ACID.				NITROGEN.					POTASH.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2192	.....	.....	9.10	.....	.....	.....	8.02	.....	8.02	.....	.....	.....	.....
.....	.....	.....	*8.00*	T	.....	.....	*8.25*	T	*8.25*	.....	.....	.....	.....
2208	.....	.....	7.68	.....	.....	.....	9.00	.....	9.00	.....	.....	.....	.....
.....	.....	.....	*8.00*	T	.....	.....	*8.23*	T	*8.23*	.....	.....	.....	.....
2227	10.44	0.20	10.64	.....	3.65	0.32	0.32	.....	4.29	.....	4.72	.....	.....
.....	*10.00*	*0.55*	*10.50*	Super	*2.67*	.....	*1.33*	Bat G, T	*4.00*	.....	*4.00*	.....	.....
2158	18.43	0.19	18.62	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2159	18.56	0.20	18.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*18.12*	*0.28*	*18.40*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2237	19.03	0.51	19.54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2303	18.48	0.24	18.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*18.29*	*0.20*	*18.49*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2052	.....	.....	27.54	.....	.....	.....	3.15	.....	**3.15**	.....	.....	.....	.....
.....	.....	.....	*26.00*	.....	.....	.....	*3.60*	.....	*3.60*	.....	.....	.....	.....
2253	**4.78**	9.01	13.79	.....	1.44	0.11	4.53	.....	6.08	.....	5.38	.....	.....
.....	*7.00*	*7.00*	*14.00*	Bn	*1.00*	.....	*4.50*	Bl, Bn	*5.50*	.....	*5.00*	.....	.....
2305	7.06	1.59	9.65	.....	2.80	0.15	2.40	.....	5.35	.....	3.75	.....	0.95
.....	*6.00*	*3.00*	*9.00*	Bn, G, Super	*2.00*	.....	*3.00*	Bl, Bn, G	*5.00*	.....	*3.00*	.....	.....
2126	.....	.....	.....	.....	15.36	.....	.....	.....	15.36	.....	.....	.....	.....
2254	.....	.....	.....	.....	15.36	.....	.....	.....	15.36	.....	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....	.....
2256	**6.61**	5.26	11.87	.....	3.62	0.10	2.28	.....	6.00	.....	3.03	.....	0.60
.....	*8.00*	*4.50*	*12.50*	Bn, Super	*4.00*	.....	*2.00*	Bl, Bn, T	*6.00*	.....	*3.00*	.....	.....
2023	.....	.....	17.42	.....	.....	.....	5.31	.....	5.31	.....	.....	.....	.....
.....	.....	.....	*13.00*	.....	.....	.....	*5.00*	.....	*5.00*	.....	.....	.....	.....
2043	.....	.....	6.32	.....	.....	.....	8.79	.....	8.79	.....	.....	.....	.....
.....	.....	.....	*7.00*	.....	.....	.....	*8.00*	.....	*8.00*	.....	.....	.....	.....
2052	.....	.....	18.11	.....	.....	.....	5.09	.....	5.09	.....	.....	.....	.....
.....	.....	.....	*13.70*	.....	.....	.....	*5.30*	.....	*5.30*	.....	.....	.....	.....
2054	.....	.....	17.48	.....	.....	.....	5.25	.....	**5.25**	.....	.....	.....	.....
.....	.....	.....	*13.50*	.....	.....	.....	*6.60*	.....	*6.60*	.....	.....	.....	.....
2068	.....	.....	17.72	.....	.....	.....	5.49	.....	5.49	.....	.....	.....	.....
.....	.....	.....	*13.70*	.....	.....	.....	*5.30*	.....	*5.30*	.....	.....	.....	.....
2164	.....	.....	6.47	.....	.....	.....	8.58	.....	8.58	.....	.....	.....	.....
.....	.....	.....	*6.95*	.....	.....	.....	*8.56*	.....	*8.56*	.....	.....	.....	.....
2176	.....	.....	11.64	.....	.....	.....	5.74	.....	5.74	.....	.....	.....	.....
.....	.....	.....	*9.50*	.....	.....	.....	*5.78*	.....	*5.78*	.....	.....	.....	.....
2193	.....	.....	5.70	.....	.....	.....	8.85	.....	8.85	.....	.....	.....	.....
.....	.....	.....	*6.32*	.....	.....	.....	*8.79*	.....	*8.79*	.....	.....	.....	.....
2257	.....	.....	7.57	.....	.....	.....	8.64	.....	8.64	.....	.....	.....	.....
.....	.....	.....	*8.50*	.....	.....	.....	*8.70*	.....	*8.70*	.....	.....	.....	.....
2055	.....	.....	.....	.....	.....	.....	10.52	.....	10.52	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*10.00*	.....	*10.00*	.....	.....	.....	.....

*2043—73% fine. *2054—89% fine. *2164—51% fine. *2193—85% fine.
*2052—75% fine. *2068—81% fine. *2176—69% fine. *2257—85% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	S. M. Neely, San Diego, Cal.		
2194	Bird Guano	J. M. Leavens, Highland	**26.96**
	Guaranteed		*40.17*
	Pacific Guano and Fertilizer Co., San Francisco, Cal.		
2216	Bat Guano	A. J. Hutchinson, Palo Alto	25.28
	Guaranteed		*24.64*
2008	Blood	B. S. Casey, Rialto	55.10
	Guaranteed		*55.44*
2021	Blood	E. A. Bemis, Rialto	54.81
	Guaranteed		*51.24*
2051	Blood	B. S. Casey, Rialto	58.21
2087	Blood	Mrs. M. E. Wallace, Rialto	**57.79**
	Guaranteed		*59.01*
2059	Special	Mrs. M. F. Blake, Rialto	35.21
	Guaranteed		*35.00*
2162*	Special	W. A. Veith, Fresno	33.8[illegible]
	Guaranteed		*34.43*
2088	Superphosphate	W. E. Nye, Highland	18.73
	Guaranteed		*20.40*
2217	Superphosphate	A. J. Hutchinson, Palo Alto	**16.98**
	Guaranteed		*19.20*
	Redlands Fruit Association, Redlands, Cal.		
2089*	Blood	C. J. Holmes, Redlands	44.98
	Guaranteed		*41.90*
2209*	Blood	Bailey & Warner, Redlands	42.48
	Guaranteed		*42.60*
2090*	Bone Meal	A. G. Simonds, Redlands	32.70
	Guaranteed		*32.92*
2091	Nitrate of Soda	C. E. Davis, Redlands	54.91
	Guaranteed		*52.50*
2061*	Tankage	J. J. West, Glendora	33.87
	Guaranteed		*32.72*
2092*	Tankage	Spoor Estate, Redlands	34.33
	Guaranteed		*35.34*
	San Bernardino Fertilizer Works, San Bernardino, Cal.		
2231	Blood	Dr. C. J. Creighton, Redlands	50.40
	Sold on Station Analyses		
2198*	Blood and Bone	G. H. Wheeler, Rialto	42.86
	Guaranteed		*39.80*
2261	Muriate of Potash	J. B. Leavens, Highland	53.48
	Guaranteed		*50.56*
2210	Nitrate of Soda	M. E. Ginn, Redlands	53.06

*2089—Whale scrap—not blood.
*2209—Whale scrap—not blood.
*2090—22% fine.
*2061—88% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.											
	Phosphoric Acid.				Nitrogen.					Potash.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2194	**5.36**	0.87	6.23	.....	0.37	1.45	3.13	....	**4.95**	.....	.....	**0.87**	.....
.....	*8.86*	*1.10*	*9.96*	.....	*0.63*	*1.67*	*4.67*	....	*6.97*	.....	.....	*1.74*	.....
2216	.....	.....	5.82	.....	1.20	0.68	2.95	.....	4.83	.....	.....	1.81	.....
.....	.....	.....	*5.50*	.....	.....	.....	.....	.....	*5.06*	.....	.....	.....	.....
2008	.....	.....	.....	.....	.....	.....	13.12	....	13.12	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.20*	....	*13.20*	.....	.....	.....	.....
2021	.....	.....	.....	.....	.....	.....	13.05	.....	13.05	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*12.20*	....	*12.20*	.....	.....	.....	.....
2051	.....	.....	.....	.....	.....	.....	13.86	.....	13.86	.....	.....	.....	.....
2087	.....	.....	.....	.....	.....	.....	13.76	.....	**13.76**	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*14.05*	.....	*14.05*	.....	.....	.....	.....
2059	7.89	1.61	9.50	.....	2.18	.....	3.67	.....	5.85	.....	2.19	.....	.....
.....	*8.00*	.....	.....	Bn, G. Supr	*2.00*	.....	*4.00*	Bl, Bn, Fs, G. T.	*6.00*	.....	*2.00*	.....	.....
2162	8.58	1.80	10.38	.....	2.16	0.10	0.07	.....	2.33	.....	**12.11**	.....	0.92
.....	.....	.....	*9.81*	Bn, G. Supr	*2.42*	.....	.....	....	*2.42*	.....	*15.10*	.....	.....
2088	15.61	2.73	18.34	.....	.....	.....	.....	....	.....	.....	.....	.....	.....
.....	*17.00*	.....	.....	.....	.....	.....	.....	....	.....	.....	.....	.....	.....
2217	**14.15**	4.29	18.44	.....	.....	.....	.....	....	.....	.....	.....	.....	.....
.....	*16.00*	*2.00*	*18.00*	.....	.....	.....	.....	....	.....	.....	.....	.....	.....
2089	.....	.....	.....	.....	.....	.....	10.97	.....	10.97	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*10.22*	....	*10.22*	.....	.....	.....	.....
2209	.....	.....	.....	.....	.....	.....	10.62	....	10.62	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*10.65*	....	*10.65*	.....	.....	.....	.....
2090	.....	.....	**27.92**	.....	.....	.....	3.05	.....	3.05	.....	.....	.....	.....
.....	.....	.....	*29.00*	.....	.....	.....	*2.88*	.....	*2.88*	.....	.....	.....	.....
2091	.....	.....	.....	.....	15.69	.....	.....	....	15.69	.....	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	....	*15.00*	.....	.....	.....	.....
2061	.....	.....	14.89	.....	.....	.....	6.10	....	**6.10**	.....	.....	.....	.....
.....	.....	.....	*11.30*	.....	.....	.....	*6.58*	....	*6.58*	.....	.....	.....	.....
2092	.....	.....	11.88	.....	.....	.....	6.24	.....	**6.24**	.....	.....	.....	.....
.....	.....	.....	*11.45*	.....	.....	.....	*6.58*	....	*6.58*	.....	.....	.....	.....
2231	.....	.....	.....	.....	.....	.....	12.00	.....	12.00	.....	.....	.....	.....
2198	.....	.....	7.30	.....	.....	.....	9.90	....	9.90	.....	.....	.....	.....
.....	.....	.....	*3.00*	.....	.....	.....	*10.00*	....	*10.00*	.....	.....	.....	.....
2261	.....	.....	.....	.....	.....	.....	.....	....	53.48	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	....	*50.56*	.....	.....	.....	.....
2210	.....	.....	.....	.....	15.16	.....	.....	....	15.16	.....	.....	.....	.....

*2092—76% fine.

*2198—61% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	San Bernardino Fertilizer Works—Continued.		
2230	Nitrate of Soda	J. N. Clark, Redlands	53.44
2259	Nitrate of Soda	J. B. Leavens, Highland	53.87
	Guaranteed		*52.50*
2135	Orange and Lemon No. 1	H. L. Bilson, Redlands	30.61
2260	Orange and Lemon No. 1	J. H. Reynolds, Redlands	27.77
	Guaranteed		*29.50*
2199*	Special	M. E. Ginn, Redlands	28.95
	Guaranteed		*28.10*
2283*	Special	G. H. Wheeler, Rialto	43.20
	Sold on Station Analyses		
2134	Sulfate of Potash	I. E. Mills, Redlands	**58.56**
	Guaranteed		*59.64*
2262	Sulfate of Potash	J. B. Leavens, Highland	60.10
	Guaranteed		*58.40*
2093*	Tankage	J. B. Leavens, Highland	32.07
	Guaranteed		*33.47*
2120*	Tankage	I. L. Lyons & Sons, Redlands	31.90
	Guaranteed		*30.43*
	Southern California Fertilizer Co., Los Angeles, Cal.		
2035	Bat Guano	Arlington Heights Fruit Co., Riverside	27.99
2036	Bat Guano	Arlington Heights Fruit Co., Riverside	28.36
2037	Bat Guano	Arlington Heights Fruit Co., Riverside	27.96
2038	Bat Guano	Arlington Heights Fruit Co., Riverside	27.98
2039	Bat Guano	Arlington Heights Fruit Co., Riverside	27.38
2062	Bat Guano	Arlington Heights Fruit Co., Riverside	27.52
2077	Bat Guano	Arlington Heights Fruit Co., Riverside	26.88
2129	Bat Guano	Arlington Heights Fruit Co., Riverside	28.28
2130	Bat Guano	Arlington Heights Fruit Co., Riverside	27.27
2131	Bat Guano	Arlington Heights Fruit Co., Riverside	26.38
2132	Bat Guano	Arlington Heights Fruit Co., Riverside	21.84
2268	Bat Guano	Arlington Heights Fruit Co., Riverside	22.40
2269	Bat Guano	Arlington Heights Fruit Co., Riverside	18.89
2273	Bat Guano	Arlington Heights Fruit Co., Riverside	45.56
2274	Bat Guano	Arlington Heights Fruit Co., Riverside	20.69
2275	Bat Guano	Arlington Heights Fruit Co., Riverside	30.85
2276	Bat Guano	Arlington Heights Fruit Co., Riverside	21.46
2301	Bat Guano	Arlington Heights Fruit Co., Riverside	23.66
2302	Bat Guano	Arlington Heights Fruit Co., Riverside	32.36
2316	Bat Guano	Arlington Heights Fruit Co., Riverside	37.23
2317	Bat Guano	Arlington Heights Fruit Co., Riverside	18.91
2320	Bat Guano	Arlington Heights Fruit Co., Riverside	17.11
	Sold on Station Analyses		
	Sparr Fruit Co. Los Angeles, Cal.		
2160	Nitrate of Soda	H. F. McGowan, Pomona	52.78
2211	Nitrate of Soda	A. H. Johnson, Monrovia	53.06
	Guaranteed		*52.50*

*2199—Considerable hoof.

*2283—62% fine. Should be classified Tankage.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID.				NITROGEN.					POTASH.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2230					15.27				15.27				
2259					15.39				15.39				
					15.00				*15.00*				
2135	4.90	6.10	11.00		1.16	0.15	2.50		3.81		5.90		
2260	4.35	5.27	9.62		1.77		2.09		3.86		**4.47**		1.50
	5.00	*5.00*	*10.00*	Bn	*2.00*		*2.00*	Bl, Bn, G.	*4.00*		*5.00*		
2199	6.14	4.53	10.67		2.08	0.10	2.29		4.47		**2.10**		
	5.00	*5.00*	*10.00*	Bn, Super				Bn, T.	*4.00*		*3.00*		
2283			8.52				9.50		9.50				
2134											**48.80**		1.84
											49.70		
2262											50.08		2.66
											48.67		
2093			15.40				5.28		**5.28**				
			15.00				*5.74*		*5.74*				
2120			**16.46**				4.80		4.80				
			20.00				*3.70*		*3.70*				
2035			8.01		2.51	1.00	1.85		5.36			1.50	
2036			7.59		2.69	1.00	1.86		5.55			1.53	
2037			7.97		2.53	0.98	1.84		5.35			1.53	
2038			7.88		2.63	0.97	1.80		5.40			1.48	
2039			7.81		2.69	0.97	1.85		5.51			1.52	
2062			7.76						5.16			1.42	
2077			8.46		2.16	0.95	1.88		4.99			1.34	
2129			5.72		1.28	1.05	3.18		5.51			2.27	
2130			5.60		1.28	1.30	2.67		5.88			2.45	
2131			5.42		1.72	0.85	2.67		5.24			1.90	
2132			9.62		1.93	0.50	1.17		3.60			0.76	
2268			5.41		1.97	0.58	1.90		4.45			1.24	
2269			9.95		1.52	0.33	0.95		2.80			0.52	
2273			4.86		2.57	1.38	6.15		10.10			2.59	
2274			12.50		1.50	0.31	0.84		2.65			0.80	
2275			8.88		0.51	0.89	3.94		5.34			2.50	
2276			11.51		1.62	0.42	1.06		3.10			0.69	
2301			13.30		0.32	0.55	1.85		2.72			2.10	
2302			8.01		1.55	1.08	3.69		6.32			1.57	
2316			6.00		1.95	1.52	4.23		7.70			2.68	
2317			13.19		1.16	0.19	0.75		2.10			0.52	
2320			10.27		1.23	0.26	0.78		2.27			0.45	
2160					15.08				15.08				
2211					15.16				15.16				
					15.00				*15.00*				

*2093—61% fine.

*2120—78% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	Swift & Co., Chicago, Ill.		
2040	Blood	Stanton Bros. & Keeling, Covina	54.64
2212	Blood	E. L. Koethen, Riverside	56.91
	Guaranteed		*54.60*
2122	Blood	John Fossett, Upland	58.38
	Guaranteed		*55.65*
2229*	Diamond "C"	J. H. Reynolds, Redlands	30.73
	Guaranteed		*29.40*
2215*	Diamond "E"	I. L. Lyons & Sons, Redlands	32.55
	Guaranteed		*33.00*
2118*	Diamond "E"	I. L. Lyons & Sons, Redlands	32.95
	Guaranteed		*33.10*
2121*	Diamond "E"	J. J. Atwood, Upland	33.86
2133*	Diamond "E"	I. E. Mills, Redlands	35.05
2228*	Diamond "E"	J. H. Reynolds, Redlands	33.51
	Guaranteed		*33.50*
2196*	Diamond "E"	Wm. Rohrig, Upland	**31.55**
2321*	Diamond "E"	Associated Fruit Exchange, Highgrove	**30.87**
	Guaranteed		*33.40*
2311	Diamond "K"	G. W. Duley, Upland	33.08
	Guaranteed		*32.40*
2116	Diamond "L"	V. R. Rickle, Upland	33.57
2297	Diamond "L"	G. W. Duly, Upland	34.03
	Guaranteed		*32.60*
2041	Diamond "M"	Dr. Shoemaker, Covina	38.81
2197	Diamond "M"	G. W. Duley, Upland	38.88
	Guaranteed		*38.80*
2186*	Special Bone and Meal	J. E. Cutter, Riverside	**25.75**
	Guaranteed		*26.27*
2117*	Tankage	J. J. Atwood, Upland	38.35
2187*	Tankage	A. P. Collins, Riverside	**37.42**
2232*	Tankage	G. G. Laidlaw, Ontario	40.58
	Guaranteed		*39.28*
2119*	Tankage	Mrs. M. Gray, Upland	39.41
	Guaranteed		*38.92*
2213*	Tankage	Mrs. K. Krull, Redlands	39.35
	Guaranteed		*39.10*
	Union Fertilizer Co., Los Angeles, Cal.		
2312	Blood	S. La Rue, Riverside	50.59
	Guaranteed		*54.32*
2022*	Bone Meal	S. La Rue, Riverside	32.24
	Guaranteed		*27.59*
2063	Fruiting	L. B. Dye, Corona	27.31
2263	Fruiting	F. D. Hudson, Riverside	28.43
	Guaranteed		*24.13*

*2229—62% fine. Some hoof.
*2115—67% fine.
*2118—69% fine.
*2121—77% fine.
*2133—77% fine.
*2228—78% fine. Some hoof.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Pounds per Hundred.												
	Phosphoric Acid.				Nitrogen.					Potash.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2040							13.01		13.01				
2212							13.55		13.55				
							13.00		*13.00*				
2122							13.90		13.90				
							13.25		*13.25*				
2229			**23.94**				3.08		3.08				
			25.00	Bn			*2.50*	Bn	*2.50*				
2115			18.42				4.69		**4.69**				
			17.50				*5.00*		*5.00*				
2118			17.18				5.03		5.03				
			17.50				*5.00*		*5.00*				
2121			17.46				5.10		5.10				
2133			**16.02**	Bn			5.70	Bl, Bn, T	5.70				
2228			18.20				4.86		4.86				
			17.50				*5.00*		*5.00*				
2196			**14.81**				5.60		5.60				
2321			20.62				4.22		**4.22**				
			17.50				*5.00*		*5.00*				
2311			22.04				3.02		3.02		**2.81**		
			22.00	Bn			*2.50*	Bl, Bn, T	*2.50*		*4.00*		
2116			16.58				4.08		4.08		**3.32**		
2297			16.60				3.87		3.87		4.39		
			16.00	Bn			*3.75*	Bl, Bn, T	*3.75*		*4.00*		
2041			13.65				5.76		5.76		4.04		
2197			**9.85**				6.68		6.68		**3.57**		1.55
			12.50	Bn			*6.00*	Bl, Bn, T	*6.00*		*4.00*		
2186			**26.90**				1.13		1.13				
			29.00				*0.82*		*0.82*				
2117			4.34				8.90		8.90				
2187			7.63				7.99		**7.99**				
2232			5.51				9.23		9.23				
			5.00				*9.00*		*9.00*				
2119			4.89				9.15		9.15				
			5.00				*9.00*		*9.00*				
2213			6.29				8.80		8.80				
			5.00				*9.00*		*9.00*				
2312							12.34		**12.34**				
							13.25		*13.25*				
2022			23.24				3.67		3.67				
			23.00				*2.47*		*2.47*				
2063	.01	7.91	14.92		1.00	0.20	1.66		2.86		3.57		
2263	7.96	0.80	8.76		0.33	1.25	2.07		3.65		3.79		0.90
	7.00	*1.50*	*8.50*	Bn, Super, G	*0.75*	*0.60*	*1.65*	Bn, G, T	*3.00*		*3.00*		

*2196—75% fine.
*2321—75% fine.
*2186—60% fine.
*2117—80% fine.
*2187—79% fine.
*2232—79% fine. Some hoof.
*2119—76% fine.
*2213—78% fine. Some hoof.
*2022—36% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From whom Obtained.	Value per Ton at Station Prices.
	Union Fertilizer Co., Los Angeles, Cal.—Continued.		
2078	Nursery	Mrs. J. E. McComas, Pomona	31.30
2304	Nursery	A. B. White, Los Angeles	32.15
	Guaranteed		*29.10*
2064	Special	B. A. Maxwell, Riverside	32.50
	Guaranteed		*33.65*
2215	Special	B. B. Wright, Riverside	22.31
	Guaranteed		*24.40*
2149	Special Fruiting	Stewart Citrus Assn., Upland	29.33
2204	Special Fruiting	Stewart Citrus Assn., Upland	29.66
2264	Special Fruiting	Stewart Citrus Assn., Upland	32.10
	Guaranteed		*29.75*
2161	Superphosphate	Wright Bros., Riverside	17.68
	Guaranteed		*20.40*
2005*	Tankage	A. L. Wright, Jr., Rialto	33.47
	Guaranteed		*33.19*
2295*	Tankage	J. E. Shaw, Riverside	34.92
	Guaranteed		*36.24*
2318*	Tankage	E. B. Cole, Highgrove	35.25
	Guaranteed		*36.48*
	Woodbridge Fertilizer Co., Los Angeles, Cal.		
2168	Nitrate of Soda	A. B. Downe, Duarte	55.12
	Guaranteed		*54.25*
2188	Nitrate of Soda	Leffingwell Rancho, Whittier	53.27
	Guaranteed		*54.84*
2189	Sulfate of Potash	Leffingwell Rancho, Whittier	58.51
	Guaranteed		*59.42*

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID.				NITROGEN.					POTASH.			
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Muriate.	From Sulfate.	Total.	Chlorin.
2078	6.51	1.62	8.13	...	0.80	1.02	3.33	.....	5.15	.	2.41	.....	1.00
2304	5.66	8.17	13.83	.....	0.75	0.62	3.52	....	4.89		1.94		0.78
.....	*6.00*	*2.00*	*8.00*	Bn, G, Super	*1.00*	*1.00*	*3.00*	Bn, G, T	*5.00*	...	*1.50*	.....	.....
2064	.....	.....	6.99	.....	1.19	1.40	4.05	....	**6.64**	. ..	1.26	.....	1.00
.....	.....	.....	*7.00*	G	*1.50*	*1.00*	*4.50*	G	*7.00*	. ..	*1.00*	.....	.....
2215	**15.13**	4.31	19.44	.....	....	....	1.04	....	1.04	.....	.....	.....	.....
.... ..	*17.00*	....	.....	Bn, G Super	..... .	....	*1.00*	Bl, Bn, G, T	*1.00*	.	....	.. ..	..... .
2149	**6.00**	4.27	10.27	.....	1.72	0.48	1.94	....	4.14	... ..	3.73	..... .	.....
2204	**6.85**	5.97	12.82	.....	1.65	0.82	1.35	....	3.82	.... ..	3.61	.. ..	0.67
2264	8.20	5.24	13.44	.....	2.25	0.42	1.55	....	4.22	... .	3.38	.....	0.80
.....	*8.00*	*1.50*	*9.50*	Bn, Super	*1.00*	*0.75*	*2.25*	Bn, G, T,	*4.00*	... ..	*3.50*	.. ..	.....
2161	**14.74**	3.48	18.22	.....	.....	.....	....	.. ..	.....	.....	.....	.....	... ..
.....	*18.00*	.....	.....	.....	.....	.....	.....	....	.....	.....	.....	.....	.....
2005	.....	.....	14.29	.....	.....	.....	5.70	....	5.70	.. ..	.... ..	..... .	.. ...
.....	.....	.....	*13.75*	.....	.....	.....	*5.75*	....	*5.75*	.....	.....	.. ..	..... .
2295	.....	.....	17.40	.....	.....	.....	5.47	....	**5.47**	.....	.....	.. ..	... .
.... .	.....	.....	*16.50*	.....	.....	.....	*6.00*	....	*6.00*	.....	.....	.....	.....
2318	.....	.....	19.14	.....	.....	.....	5.14	....	**5.14**	. . .	....	.....	.. ..
. .. ..	.....	.....	*16.50*	.....	.....	.....	*6.00*	....	*6.00*	.....	.....	.....	... .. .
2168	.. ..	.....	.....	.....	15.75	.....	....	....	15.75	.. .	.....	.. ..	.....
.....	.....	.....	.....	.....	*15.50*	.....	.....	....	*15.50*	.....	.....	.. ..	....
2188	.....	.....	.....	... .	15.22	.....	....	.....	**15.22**	.... .	.....	.. ..	.. ..
.....	.....	.....	.....	.....	*15.67*	.....	....	....	*15.67*	.....	.....	.....	.....
2189	.....	.....	.....	.....	.....	.....	....	.....	.....	.....	**48.76**	.....	1.67
.....	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	*49.52*	.. ..	..... .

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HOW TO INCREASE THE YIELD OF WHEAT IN CALIFORNIA

BY

G. W. SHAW

Hauling grain to warehouse.

BULLETIN No. 211

(Berkeley, Cal., February, 1911)

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HOW TO INCREASE THE YIELD OF WHEAT IN CALIFORNIA

BY

G. W. SHAW.

The particular feature which has dominated grain culture in California, and on the Pacific coast generally, has been mass production, rather than maximum production per unit of area or quality of product. But with the inevitable ultimate deterioration of soil under such a practice, heightened by the encroachment of other crops, there has been a notable falling off in the production *in toto*, as well as in the yield per acre, during recent years. While grain farming on an extensive scale is not an industry to be particularly encouraged when natural conditions are such as to make more intensive crops safe, yet it is still, and is destined to be for all time, a very important industry in California; and as one of the staple crops of a general farm is worthy of not only much encouragement but also the greatest aid that can be given it by scientific research. Further, on account of climatic and topographical conditions there will always be large areas in the state in which cereal culture will be the principal interest.

How to produce more grain of better quality per acre, then, is a very pertinent problem. Under a special appropriation of the State Legislature the Agricultural Experiment Station of the University of California has conducted for the past five years investigations having in view a solution of this problem, and some very important practical and scientific results have been secured. It is the aim of this bulletin to set forth in as brief a manner as possible some of the more important results bearing upon the question of an increased yield, leaving the more intricate problem, the effect of environment upon the gluten content of wheat, almost wholly for discussion in a subsequent publication. On account of the limited funds available for printing, it will be possible to set forth little more than a summary of the work at this time.

NOTE OF ACKNOWLEDGMENT.—The writer wishes to express his indebtedness to Messrs. A. J. Gaumnitz, J. T. Bearss, and H. F. Blanchard, who have been entrusted with the execution of the details of the experiments which are discussed herein.

Fig. 1.—Birdseye view of California Cereal Station, Sacramento Valley.

Fig. 2.—General view of grain plats on the Tulare Station, 1908.

The investigations covered by this report are in general based upon results and observations covering a long period. For a limited time a portion of the work was conducted in co-operation with the Bureau of Plant Industry of the United States Department of Agriculture.

Both the field and laboratory investigations have covered a wide range. They embrace the relative value of deep vs. shallow plowing, early vs. late seeding, drill vs. broadcast seeding, trials with fertilizers, the effect of certain rotation schemes, the improvement of the soil through green-manuring, moisture conservation, the treatment of grain for the prevention of smut, the value of exchanging seed, cleaning the land from weeds both by cultural methods and the use of chemical sprays, and finally, variety trials and the development of better types of grain than those commonly grown. In the study of the general question of environmental influence upon the quality of wheat, and also the selection work involving an increase of the gluten content, there has of course been a large amount of chemical work required. Questions involved along these lines have been the influence upon the gluten content of the length of the growing period, of the time of harvest, of the time of seeding, of the time the wheat plant receives its moisture, the influence of sunshine and of the composition of the soil. The environmental question as affecting the gluten content will be the theme of a separate report.

In this report an effort has been made to so correlate the cultural results and observations that they may be of immediate benefit to the California grain growers, in effecting improvement in soil fertility, increasing the yield of grain, and improving the milling quality of the grain produced.

It should be said that these results should be considered as simply the foundation for more extensive work. *The element of time is an all-essential one for the solution of such problems as these.* This would be true even though the problem was merely the development of grain giving higher yields, but, with the introduction of the problem of increasing the gluten content, the element of time is of even greater importance.

The old methods of grain growing still persist in California. They are generally very simple and very crude. At first satisfactory returns were obtained because of an unusually fertile virgin soil. At the outset there was an annual cropping of the land to the cereals with no attempt to either rotate crops or restore any of the humus that such a system destroys. In order to cover as large an

acreage as possible the crudest methods of culture were practiced. The practice consisted simply of three- or four-inch plowing, broadcasting the seed, and harrowing it in. But little attention was paid to the selection of pure seed, and far too often the growers purchased a second or a third grade seed under the false notion that anything that would sprout was good enough.

The more important changes which have taken place since the introduction of the above named crude practices have been the replacing of the header and stationary thresher by the combined harvester, and the quite general introduction of the practice of summer-fallowing of land.

The development of the combined harvester has without doubt decreased the cost of production where grain is harvested upon a large scale, but it has at the same time tended to encourage a desultory system of culture, rendered the fields very foul both by the general distribution of weed seeds and because by the time the grain is harvested in this manner practically all the serious weeds have fully ripened their seed; and further, on account of the long time the grain is left in the field after maturity, has tended to seriously increase the loss from shattering of the grain from the wind. This latter condition is especially true in the Sacramento Valley. It is very questionable, then, as to whether the combined effects of these undesirable factors have not more than offset the decreased cost.

The summer fallow practice was introduced for two reasons: first, it was an attempt to save as much of two season's precipitation as possible for the production of a single larger crop; second, to clean the land of weeds resulting from continued grain culture. The latter effect has been largely offset by the use of the combined harvester.

The shallow preparation of land and the continual practice of burning off the straw has had a very bad effect upon the humus content of the top foot of the soil, which in turn has so affected its physical condition, generally speaking, as to materially reduce its moisture capacity and seriously affect the yield of grain. Further, the earlier seeding made possible by the summer fallow practice has also reduced the quality of the grain, as shown by the analyses of a large number of early and late seeded grain.

During recent years, mainly as a result of the reduction in size of some grain farms, and the educational efforts throughout the state conducted by the University of California, there has been an increase of the depth of plowing on the part of some farmers, but in general the same careless methods of culture still hold.

To summarize, the general effect of the past and present methods has been the development of a poor physical condition of the land, largely as a result of the depletion of the humus, until the soil refuses to produce profitable crops of the commonly grown varieties of wheat under the old system of farming, and, besides, the soil has been made very foul with weeds.

CULTURAL EXPERIMENTS.

DEEP VS. SHALLOW PLOWING.

At the outset of these investigations a large number of cultural experiments were planned, principally in the Sacramento Valley. It is almost the universal practice in California to give grain land a very shallow preparation, probably 90 per cent. is seldom, if ever, plowed to exceed three or four inches in depth. Although this is so generally the practice, yet it is diametrically opposed to the most fundamental principles of "dry-land farming," so-called, *viz.*, securing a deep penetration of water and retaining it in the soil till late in the season for properly maturing the crop and to encourage deep rooting.

On the University Farm at Davis, where the average precipitation is about 20 inches, forty trials of deep vs. shallow preparation of land for grain have been tried within the past three years and the results are set forth in the following table:

TABLE I.—RESULTS OF DEEP VS. SHALLOW PLOWING FOR GRAIN.

AVERAGE OF 40 TRIALS.

	Wheat bu.	Barley bu.	Effect on succeeding crop of Barley
Deep plowing	29.78	75.98	25.36
Shallow plowing	21.67	69.30	17.32
Gain	8.11	6.68	8.04
Percentage increase	37.40	9.70	46.50
Increased money value	$7.78	$3.34	$4.02

It should be stated that this deeper preparation of land for grain applies either to the plowing for summer fallow or for seeding previous to the middle of January. If land is to be prepared later than such date then a more shallow preparation with thorough working of the surface is undoubtedly preferable.

Deep plowing to enable quick and deep penetration of water, and followed by immediate subpacking of the soil, either by the use of a disk set rather straight, or on light soils a sub-surface packer, and finally a thorough preparation of the surface seed-bed, are fundamental principles of grain production.

The average yield of wheat in the State for the past three years has been 14.5 bushels per acre. On the Cereal Stations, over the same period, the average yields, including all varieties, some of which were very poorly adapted to California conditions and therefore giving light returns, has been as follows:

	Wheat, bu. per acre	Barley, bu. per acre
Tulare	35.2	53.4
Davis	40.4	45.4
Ceres	33.2	19.1
Average	36.3	39.3

In this connection it must be remembered that neither irrigation nor fertilization has been practiced on these tracts except in certain plats which are not included in the averages. This increased average yield has been almost entirely due to a deeper plowing than is customary, a better preparation of the seed bed, and a well cultivated summer fallow. On the experimental tract at the University Farm Davis, the average yield of barley for the last three years has been 45.4 bushels per acre. The same land at Davis under more shallow preparation, over the same period has returned a yield of 37.9 bushels per acre of barley.

Much of the grain land of the State at present, as a result of continued shallow culture, has developed a very tenacious plow-sole which materially lessens its ability to absorb moisture rapidly and freely. On such lands it may not be advisable to plow to the full depth of eight inches at one operation, but rather to *increase the depth gradually until eight-inch plowing can be the regular practice.* In many localities a plowing to a depth of twelve inches is advisable, especially if the land has become exceedingly compact and hard. While the benefits from deep plowing may not be so evident the first season, unless great care is taken to sub-pack the soil in order to establish good capillary connection in the undersoil, *the results are of permanent character.* The subsoil is materially benefited by aeration and other climatic influences, and the effects of deep plowing will be noticeable for several succeeding crops. For an illustration of this, note the residual effect of deep plowing on the barley crop as shown in Table I.

DISKING VS. PLOWING OF LAND FOR SPRING SEEDING.

When the season has far advanced before seeding particular care must be taken not to leave the soil so loose as to cause rapid drying out. Generally under such conditions the disk serves a better purpose

in the preparation of the land than the plow, even though the plowing be shallow. Several trials of this have been made and are set forth in the subjoined table.

TABLE II.—DISKING VS. PLOWING OF LAND FOR SPRING SEEDING.

	Land disked bu.	Land plowed bu.	Difference
1909	52.00	50.00	2.0
1910	45.80	41.50	4.3
Average	48.90	45.75	3.1

THE EFFECT OF INCREASING THE HUMUS OF THE SOIL.

California soils in the grain growing sections are low in humus. For many years the writer has maintained persistently that *the maintenance and increase of the humus component of the soil is the most important single factor in California agriculture.* Humus is vegetable or animal matter in process of decay. Its presence in ample quantity in a soil means success; its lack means disaster, and this is particularly true in dry-land farming. *To lessen seriously the humus content of a soil is to lower the crop producing powers of the individual farm and impair natural resources.*

HUMUS benefits the soil physically:

(1) By increasing its water holding capacity.
(2) By increasing its warmth.
(3) By bettering its texture.

HUMUS benefits the soil chemically:

(4) By supplying nitrogen directly.
(5) By supplying phosphoric acid, potash, and lime directly.

HUMUS benefits the soil biologically:

(6) By affording food for micro-organic growth.

Very pertinent to this is an experiment described by Professor Cavanaugh, of Cornell Experiment Station. He undertook the analysis of soil from an orchard where three successive crops of crimson clover had been plowed under. In order to learn what change, if any, had been produced, another sample from the same field, but where no clover had grown, was also examined. These two samples were taken about 20 feet apart, and there was no reason to suppose that previous to the growing of the clover the soil in these two places was materially different. The amounts of moisture, humus and nitrogen, were determined.

The results were as follows:

	With no Clover Per cent.	After Clover Per cent.	Difference
Moisture	8.75	15.00	6.25
Humus	1.91	2.94	1.03
Nitrogen	.12	.21	.09

Possibly a more definite idea may be had of these differences if the increased amounts per acre are calculated. Since the soil was in an orchard, where the extreme depth of cultivation was about six

Fig. 3.—Pea crop to be turned under for increasing the humus supply of the soil. Yuba City Station.

inches, the samples were taken to that depth. The average weight of soils per acre for a depth of six inches is about 750 tons, or 1,500,000 pounds; 6.25 per cent. of this amount, in the case of moisture, would show an increased water-holding capacity of 93,750 pounds, or 46⅞ tons. This result was made possible by the increased amount of humus, and a careful system of surface tillage. If there had been no other benefit from this system of green-manuring than this increased power to hold moisture, it would have more than paid for seed and labor, for an extra forty-six tons of water is very convenient

in a dry time, and might easily be the turning point between success and failure.

Already the wheat soils of the San Joaquin Valley have had their humus content so seriously impaired as to render it extremely doubtful

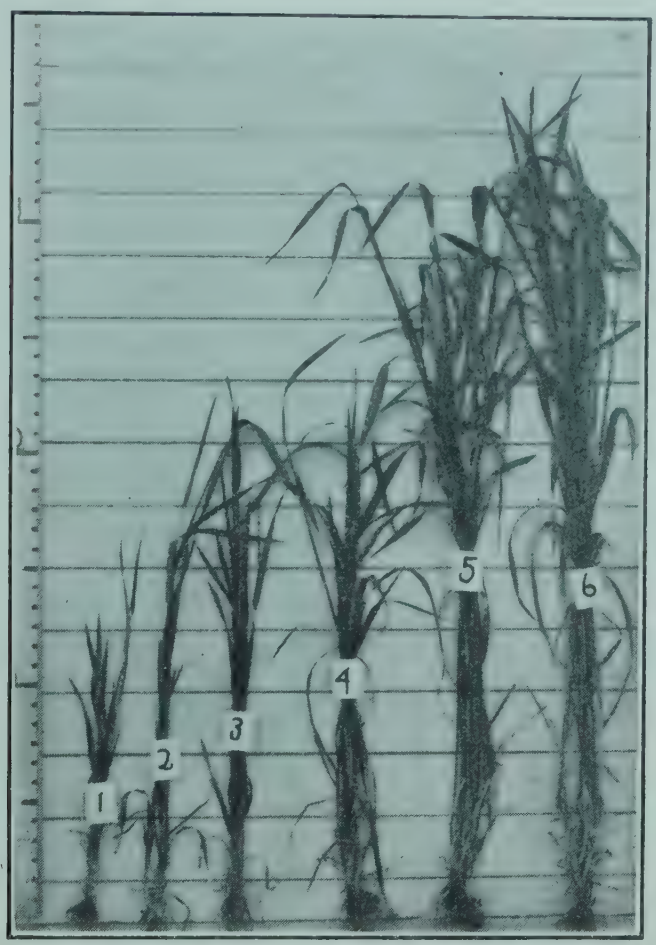


Fig. 4.—Wheat plants from six plats treated differently, showing comparative development: (1) from plat continuously seeded to wheat; (2) from plat bare-fallowed in 1908; (3) from plat upon which horse beans were grown and plowed under in 1908; (4) from plat upon which Canadian field peas were grown and plowed under in 1908; (5) from plat upon which rye and vetch were grown and plowed under in 1908; (6) from plat upon which rye was grown and plowed under in 1908.

if it is at all possible to produce three good successive crops of wheat upon the same land, largely on account of their lack of moisture-holding power. This is not equally true of the heavier soils represented by the University Farm at Davis.

Continued grain culture under shallow preparation over a long

period has seriously affected the naturally low humus supply of the grain lands. This condition has been rendered worse by the burning of the straw and biennial culture necessitated by a limited precipitation. The only way to either maintain or increase the humus supply is by the use of stable manure or the growing of green-manure crops to be turned under. The former is out of the question over any considerable area, and *the only recourse is the growing of green-manure crops to be turned under.*

Fig. 5.—Wheat growing on plat which has been continuously seeded to the same crop. (See figure 4 (1).)

At the outset of this work a scheme was laid out on each of the Stations to determine the most economical crop to be grown to accomplish this result, and the effect of such treatment upon the yield of grain. Essentially the same scheme was employed both in the San Joaquin Valley, on a sandy soil, and in the Sacramento Valley, on a heavy soil. While the trials have not been conducted sufficiently long to be beyond possibilities of slight errors, yet they are sufficient to give an idea of what may be reasonably expected from turning under green-manure crops and as a factor in increasing the grain crops of California should be given the closest attention.

In these experiments it has been the general practice to plow the land about eight inches deep at the time of turning under the green-manure crop, and then to be careful to so treat the land either with disk or sub-surface packer as to be certain to establish close contact of the soil with the green stuff turned under and to maintain proper capillary connection between the top soil and under soil. This is necessary to secure the most effective results from the green stuff and to prevent drying out of the top soil.

TABLE III.—EFFECT OF DEEP PLOWING AND GREEN-MANURE CROPS ON THE YIELD OF WHEAT ON SANDY SOIL IN SAN JOAQUIN VALLEY (CERES).

No. of Plat	Preceding treatment of crop	Yield per acre in bu. 1909	1910	2-yr. av.
1	Bare fallow	28.0	38.6	33.3
2	Horsebeans (turned under)	35.3	40.0	37.6
3	Canadian field peas (turned under)	33.7	39.3	36.5
4	Wheat after wheat	15.7	.....	15.7*
5	Rye and vetch (turned under)	50.7	57.3	54.0
6	Rye (turned under)	51.3	53.3	52.3

* One year only.

Illustrations showing the field appearance of the several tracts are shown as Figs. 5 to 9.

In discussing the results of this work in 1909, Mr. H. F. Blanchard, at that time in charge of the Ceres Station, says:

"The cultivation of the plats indicated in the table was as follows:

"In the fall of 1907 all of the plats were laid out on summer-fallow land and all were plowed to a depth of 6 inches and harrowed. Plat 1 was allowed to remain fallow. Plat 4 was sown to wheat. Plats 2, 3, 5, and 6 were sown, as indicated, to horse beans, Canadian field peas, rye and vetch, and rye alone. The vetch in plat 5 made a very poor stand, while the horse beans and peas made a fairly good stand. The stand of rye was excellent."

"In March, 1908, plats 1, 2, 3, 5, and 6 were plowed 8 inches deep, harrowed, and kept clean throughout the summer and fall. Plat 4, which yielded at the rate of 26 bushels of wheat to the acre, was double-disked immediately after the wheat was taken off."

"The first of December, 1908, all plats were plowed to a depth of 5 inches and sown to wheat. The resulting yields are given in Table III. In two years' time the plat continuously seeded to wheat has produced 41 bushels of wheat. However, the first year's yield, 26 bushels, was produced after summer fallow and the second year's yield, 15.66 bushels, shows a decrease of nearly half. It is quite probable that the third year will give a very low yield and that in a

Fig. 6.—Wheat growing on plats which had been barefallowed in 1908. (See figure 4 (2).)

Fig. 7.—Wheat growing on plat on which Canadian field peas were grown and plowed under in 1908. (See figure 4 (3).)

Fig. 8.—Wheat growing on plat on which rye and vetch were grown and plowed under in 1908. (See figure 4 (5).)

Fig. 9.—Wheat growing on plat on which rye was grown and plowed under in 1908. (See figure 4 (6).)

series of five years the quantity of wheat produced from continuously seeded plats would be much smaller than from the other methods of cultivation."

"It follows, then, from this experiment, that deeply plowed summer fallow will give much better yields than shallow plowed, continuously cropped land. Plats 1, 2, 3, 5, and 6 were all plowed at the same depth, and the last four were fallowed also after turning under the green crops. The yields indicate that the addition of organic matter (humus) to the soil is beneficial in increasing the production of crops and that this increase is proportional to the quantity rather than the quality or kind of organic matter added."

Fig. 10.—Plat 30, wheat after wheat, University Farm, Davis. Contrast with Figs. 11 and 12. (See Table IV.)

At Davis the general character of the cultivation has been the same on the several plats, and the results have been less striking only because the soil on that station is normally richer in humus and naturally more retentive of moisture.

The results in tabulated form are shown below:

TABLE IV.—EFFECT OF DEEP PLOWING AND GREEN-MANURE CROPS ON THE YIELD OF WHEAT ON HEAVY SOILS AT DAVIS, 1907-10.

Crop or treatment	Yield per acre bu.
Wheat after wheat	32.7
Wheat after fallow	41.6
Wheat after horsebeans (turned under)	43.1
Wheat after field peas (turned under)	43.3
Wheat after wheat	38.6
Wheat after horsebeans (turned under and followed by Kafir corn)	42.3
Wheat after rye and vetch (turned under)	44.4
Wheat after burr clover (turned under)	48.2

Fig. 11.—Plat 39, University Farm, Davis. Wheat after horsebeans (turned under) followed by Kafir corn. Contrast with Fig. 10. (See Table IV.)

Fig. 12.—Plat 41, University Farm, Davis. Wheat after turning under a crop of rye and vetch. Contrast with Fig. 10. (See Table IV.)

The inevitable conclusion from the experiments conducted at both of these stations along these lines is that *by means of deeper plowing and the growing of green-manure crops during the winter the yields of grain can be very materially increased.* It is certainly reasonable in the light of these experiments that by the adoption of better methods of culture, and improvement of the humus content of the soil by green-manuring, the average wheat yield of California can, without much trouble, be raised to nearly double what it is at present and at the same time the soil be put into a more favorable condition for other crops.

Fig. 13.—Canadian field peas to be turned under to increase the humus and the moisture capacity of grain land. University Farm, Davis, 1908.

CROPS TO BE USED FOR GREEN-MANURING.

A large variety of plants have been tried out for green-manuring purposes, either directly in this rotation scheme, or separately, but under the present condition of the seed market only a limited number of varieties are obtainable.

In the light of the experiments discussed above, *it appears that it is rather the mass of green stuff that can be introduced into the soil that counts, rather than the character of the material.* This is a condition which seems to hold at present, but probably is not likely to be permanently true. *The immediate effect of the green-manure stuff is to improve the moisture holding capacity,* and the evidence would

seem to show that this is the condition of first importance, and that the matter of direct nitrogen supply is of secondary consideration. Results secured with field peas or vetches would doubtless be more lasting in their effect, and the quality of humus better, but unfortunately there is much difficulty in securing a sufficient growth of either of these crops on many of the grain lands in their present physical condition. *The most favorable immediate results can probably be secured by the use of rye.* Under favorable conditions peas, seeded at the rate of one hundred pounds per acre, have given good results in the Sacramento Valley. The Niles pea is probably somewhat more favorable than the Canadian field pea, since it grows more rapidly and is somewhat earlier in maturing. On the lighter soil of the San Joaquin Valley, peas do not make as rank a growth as in the Sacramento Valley. A favorable mixture is peas and rye sown together at the rate of 60 pounds of peas and 30 pounds of rye per acre.

Under the present soil conditions, and to lay a foundation for the future use of peas or other legumes, winter rye is to be highly recommended. This should be seeded at the rate of 80 pounds per acre.

The essential thing is to secure the maximum growth of green stuff during the winter to be turned under in the early spring. The grower should use the plant which he finds will make the most rapid growth under his own conditions. Rye is usually a sure crop on any kind of soil; peas or vetches are less certain to make a large growth. But whenever possible to secure a satisfactory growth a legume is preferable, because it makes an addition of nitrogen to the soil, and thus improves its chemical as well as physical conditions.

Whatever crop is used it should be seeded as soon as it is possible to either shallow-plow or disk the land. If the land has been disked immediately after the removal of the grain crop, the green-manure crop can usually be seeded by December first, though occasionally it may be necessarily later. In the case of legumes it is not advisable to sow later than December fifteenth, but with rye the seeding may be done as late as January first. The crop should be turned under from the first to the middle of March, before the ground is too dry for deep plowing. The aim should be to secure as long a growing period for the green-manure crop as possible without leaving the ground so late as to prevent humification.

It is a great aid to early preparation of stubble land to disk the land immediately after the crop is harvested. This tends to conserve the residual moisture, and enables it to make use of the light fall precipitation, and furnishes a fine soil to be turned under in plowing, and it still further encourages the early germination of weed seeds.

THE USE OF COMMERCIAL FERTILIZERS ON GRAIN.

Among the cultural experiments a series of fertilizer tests was planned with the idea of ultimately securing answers to the following questions:

A. Does an increase in the available nitrogen in the soil increase the gluten of the wheat and the yield per acre?

B. What is the effect of an increase of lime upon the yield of grain both with and without the addition of nitrogen?

C. Does an increase in the nitrogen content of the soil in the presence of liberal amounts of phosphoric acid increase the gluten content of the grain, or the yield?

D. Does increasing the phosphoric acid increase either the gluten content or the yield of wheat?

E. Does increasing the potash supply, either alone or in combination with other materials, increase the gluten content or the yield per acre?

F. What is the relative value of nitrogen in nitrate of soda and in organic form (dried blood)?

G. Plats 23, 24, and 25 are to have legumes grown upon them every third year and the cereal crops the other two years, the latter crops to be fertilized with superphosphate and potash on the second crop after the legumes. The results of this plan of operation are to be compared with the average of the check plats and with 21 and 27.

For the purpose of answering these questions the following fertilizer scheme is being carried out:

TABLE V.—EXPERIMENT A—FERTILIZERS ON WHEAT.

UNIVERSITY FARM, DAVIS, 1907-10.

Plat No.	Treatment on one-twentieth acre plats	Av. yield for 3 yrs. Bu. per acre Wheat	Yield per acre, 1907-08 Barley
1	Nitrate of soda, 5 lbs.; hydrated lime, 132½ lbs.	39.6	22.1
2	Nitrate of soda, 5 lbs.	44.7	13.3
3	Hydrated lime, 132½ lbs.; nitrate of soda, 5 lbs.	28.8	12.8
4	Check; no fertilizer	30.1	13.6
5	Nitrate of soda, 5 lbs.; sulfate of potash, 6 lbs.	30.5	17.8
6	Nitrate of soda, 10 lbs.	35.0	15.6
7	Check; no fertilizer	35.3	13.9
8	Nitrate of soda, 5 lbs.; superphosphate, 20 lbs.	38.7	17.2
9	Nitrate of soda, 10 lbs.; sulfate of potash, 6 lbs.	27.7	17.2
10	Nitrate of soda, 10 lbs.; superphosphate, 20 lbs.	30.1	18.3
11	Check; no fertilizer	27.7	13.3
12	Superphosphate, 20 lbs.	30.4	15.5
13	Sulfate of potash, 6 lbs.	33.5	16.1
14	Check; no fertilizer	34.7	14.3

NOTE.—While a fertilizer scheme was originally planned for each of the stations, it finally developed that either the extreme weediness or the uneven character of the soil where the plats were located rendered the results untrustworthy, except on the University Farm tract.

Plat No.		Av. yield for 3 yrs. Bu. per acre Wheat	Yield per acre, 1907-08 Barley
15	Nitrate of soda, 5 lbs.; sulfate of potash, 12 lbs.	42.6	12.2
16	Nitrate of soda, 5 lbs.; superphosphate, 30 lbs.	35.5	17.8
17	Nitrate of soda, 10 lbs.; superphosphate, 30 lbs.; sulfate of potash, 6 lbs.	37.5	19.4
18	Nitrate of soda, 5 lbs.; superphosphate, 30 lbs.; sulfate of potash, 12 lbs.	36.1	15.0
19	Nitrate of soda, 5 lbs.; superphosphate, 30 lbs.; sulfate of potash, 12 lbs.	35.7	17.8
20	Nitrate of soda, 5 lbs.; superphosphate, 50 lbs.; sulfate of potash, 6 lbs.	36.5	18.3
21	Check; no fertilizer	34.5	13.9
22	Sulfate of potash, 6 lbs.; superphosphate, 30 lbs.	32.0	12.2
23	Dried blood, 7 lbs.; superphosphate, 30 lbs.; sulfate of potash, 6 lbs.	31.8	15.6
24	Legume, 1907-08; no fertilizer, 1908-09; superphosphate, 30 lbs.; sulfate of potash, 6 lbs., 1909-10	37.7	16.6
25	Superphosphate, 30 lbs.; sulfate of potash, 6 lbs., 1907-08; legume, 1908-09 (Canadian field pea); no fertilizer, 1909-10		
26	No fertilizer, 1907-08; superphosphate, 30 lbs., 1908-09; sulfate of potash, 6 lbs., 1908-09; legume, 1909-10		
27	Check; no fertilizer	34.4	15.0

The experiments have not yet been conducted a sufficiently long time to furnish conclusive data, yet the results for three years furnish certain indications which are suggestive, and from them the following tentative conclusion may be drawn.

THE GENERAL EFFECT OF NITROGENOUS FERTILIZERS ON THE YIELD OF WHEAT AT UNIVERSITY FARM, DAVIS.

The general effect of nitrate of soda upon the yield of wheat for the past three years on the plats at the University Farm at Davis is shown by collecting the yields as expressed above and comparing with their respective check plats.

PLATS RECEIVING NITRATE OF SODA.

No. of Plat	Yield per acre bu.
1	39.66
2	49.66
Average for 2 years	42.16
6	34.90
5	30.47
10	30.01
17	37.48
8	38.65
Average for 3 years	34.30

PLATS RECEIVING NO NITRATE OF SODA.

No. of Plat	Yield per acre bu.
3	32.96
4	35.31
	34.14
7	35.28
13	33.47
12	30.42
19	35.72
12	30.42
	33.06

This comparison would seem to show that in the case of wheat the increased yield per acre that can be secured from the use of nitrates on soils similar to those at the University Farm is but slight. It should be said in this connection that nitrification has been found to have taken place to an unusual depth—12 feet or more—on these soils, hence it is not strange that the above results should show such a small increase from the use of nitrates.

In the matter of nitrate nitrogen as compared with organic nitrogen in a complete fertilizer there has been a distinct advantage in favor of the former as shown below:

	Plat No.	Yield
Nitrogen as nitrate in complete fertilizer	20	36.51
Nitrogen as blood in complete fertilizer	23	31.88
Gain		4.63

GENERAL EFFECT OF PHOSPHATIC FERTILIZERS ON THE YIELD OF WHEAT AT UNIVERSITY FARM, DAVIS.

Collecting the results from Table V in a similar manner for the plats carrying phosphates in the form of superphosphates we obtain as follows:

Plats Receiving Superphosphate.		Plats Receiving no Superphosphate.	
No. of Plat	Yield per acre bu.	No. of Plat	Yield per acre bu.
8*	44.65	2*	44.66
10	30.01	6	34.90
12	30.42	11	27.70
20	36.51	18	36.05
22	32.02	13	33.47
Average for 3 years	32.24		33.03

* 2 years only, not included in average.

Here it is found that for the past three years the general effect of phosphates upon the yield of wheat on these soils has been negative rather than positive.

THE GENERAL EFFECT OF POTASH UPON THE YIELD OF WHEAT AT THE UNIVERSITY FARM, DAVIS.

Plats Receiving Sulfate of Potash.		Plats Receiving no Sulfate of Potash.	
No. of Plat	Yield per acre bu.	No. of Plat	Yield per acre bu.
5*	30.5	2*	44.7
9	27.7	6	35.0
13	33.5	14	34.7
15	42.6	5	30.5
19	35.7	18	36.1
Average	34.9		34.1

* 2 years only, not included in average.

The general effect of the potash fertilizer has been very slight in these soils during these trials.

The total general effect on the fertilized plats has only been an increase of 0.8 bushel per acre, which of course is altogether too small to warrant their use on these soils for wheat production.

FERTILIZER TRIALS UPON BARLEY AT UNIVERSITY FARM, DAVIS.

In the season of 1907-08 similar trials of fertilizer were made upon barley with the following results:

GENERAL EFFECT OF NITROGENOUS FERTILIZER ON BARLEY AT UNIVERSITY FARM, DAVIS.

Plats Receiving Nitrate of Soda.		Plats not Receiving Nitrate of Soda.		
No. of Plat	Yield per acre bu.	No. of Plat	Yield per acre bu.	Gain or Loss
1	22.1	3	12.8	+9.3
2	13.3	4	13.6	—0.3
5	17.8	13	16.1	+1.7
6	15.6	7	13.9	+1.7
6	15.6	2	13.3	+2.3
6	15.6	4	13.6	+2.0
8	17.2	12	15.5	+1.7
9	17.2	5	17.8	—0.6
9	17.2	13	16.1	+1.1
10	18.3	8	17.2	+1.1
10	18.3	12	15.5	+2.8
17	19.4	19	17.8	+1.6
18	15.0	22	12.2	+2.8
Average	17.1		15.0	+2.1

GENERAL EFFECT OF PHOSPHATES UPON THE YIELD OF BARLEY AT UNIVERSITY FARM, DAVIS.

Plats Receiving Superphosphate.		Plats Receiving no Superphosphate.		
No. of Plat	Yield per acre bu.	No. of Plat	Yield per acre bu.	Gain or Loss
12	15.5	11	13.3	+2.2
8	17.2	2	13.3	+3.9
10	18.3	6	15.6	+2.7
16	17.8	2	13.3	+4.5
20	18.3	18	15.0	+3.3
19	17.8	15	12.2	+5.6
22	12.2	13	16.1	—3.9
Average	16.7		14.1	+2.6

GENERAL EFFECT OF POTASH UPON THE YIELD OF BARLEY AT UNIVERSITY FARM, DAVIS.

Plats Receiving Sulfate of Potash.		Plats Receiving no Sulfate of Potash.		
No. of Plat	Yield per acre bu.	No. of Plat	Yield per acre bu.	Gain or Loss
5	17.8	2	13.3	+4.5
9	17.2	6	15.6	+1.6
13	16.1	14	14.3	+1.8
15	12.2	5	17.8	—5.6
19	17.8	18	15.0	+2.8
Average	16.2		15.2	+1.0

As to the general effect of the fertilizer plats as against those unfertilized there is shown an increase of 3 bushels per acre.

A TRIAL OF SUPERPHOSPHATE UPON GRAIN.

In addition to the regular fertilizer trials on the University Farm, a series of co-operative trials with superphosphate were conducted by a number of growers during the season of 1909-10. In these trials both the seed and fertilizer were drilled at the same time with a Superior Combined Fertilizer and Grain Drill. A study of the table will show that no profitable results were obtained in any of the trials with superphosphate alone, except in the case of the Experiment No. 3 at Corcoran. This should not be taken, however, as demonstrating that superphosphate should not be used for grain, as it represents but one season's work. The data are only valuable as supplementing other work, and are published only as a matter of record of work. The results of these tests are shown in tabulated form below:

TABLE VI.—SHOWING CO-OPERATIVE TRIALS OF SUPERPHOSPHATE UPON GRAIN CROPS, SEASON OF 1909-10.

No. of Experimenter	Locality	Kind of Grain	Rate of seeding Lbs. per acre	Date of seeding	Character of Soil	Area seeded: acres		Yield per acre		Lbs. Gain or Loss
						Fertilized	Unfertilized	Fertilized	Check	
(1)	Erle	Tex. Red oats	65	Nov. 29-Dec. 23	Light clay	49.70	47.75	1063	989	+ 74
(2)	Davis	Chul wheat	100	Feb. 2-14		25.50	25.70	1123	986	+134
(3)	Corcoran	Barley	70	Nov. 28-Dec. 15	Sandy loam	18.33	19.81	2351	1930	+421
(4)	Oakdale	.....	.....	.....	.....	.....	.....	.....	.....	.....
(5)	Berlin	Wheat	115	Nov. 18-26	Clay loam	43.80	43.49	1280	1218	+ 68
(6)	Dixon	Wheat	112	Feb. 1-8	Clay loam	21.60	21.61	2387	2426	— 39
(7)	Oakdale	Wheat	90	Dec. 15-24	Sandy loam changing to adobe	20.9	10.2	608	629	— 19
(8)	Newman	.....	.....	.....	.....	.....	.....	.....	.....	.....
(9)	Montpelier	Barley	75	Jan. 27-Feb. 2	.....	27.7	77.7	521	412	+ 9
(10)	Livingston	Oats	90	Jan. 12-20	Sandy loam	27.55	28.32	457	544	— 97
(11)	Hollister	Wheat	60	Jan. 11-31	Heavy clay	46.25	31.50	715	693	+ 22
(12)	Madera	Barley	62	Jan. 31-Feb. 2	Clay loam	Failure from lack of moisture				
(13)	Davis	Barley	100	Feb. 20-Mar. 1	Clay loam	35.45	34.81	2030	2019	+ 11

DRILL VS. BROADCAST SEEDING.

Fully 90 per cent. of California grain growers still broadcast their grain notwithstanding drilling of seed has been shown to be much more effective. In order to demonstrate this under our own conditions, twenty-two comparative trials have been made, other conditions being the same, and the results are tabulated below:

Fig. 14.—Drilling wheat at University Farm, Davis.
(See Table IX.)

TABLE IX.—RELATIVE RESULTS FROM DRILLED VS. BROADCAST SEEDING UPON THE YIELD OF GRAIN.

AVERAGE OF 22 TRIALS.

	Barley	Wheat
Drilled	70.80	34.85
Broadcast	64.43	31.60
	6.37 bu.	3.25 bu.
Percentage increase	9.9	10.3
Money value	$3.18	$3.12

It pays to drill instead of broadcast seed.

TIME OF SEEDING.

It is of course impossible to give any fixed date at which seeding should be done because of so widely varying climatic conditions, and the impossibility of seeding a large acreage within a few days. Generally speaking, however, *early seeding should be encouraged for the securing of a high yield.* The quality of wheat produced on early seeded areas, however, will be somewhat lower than upon those late seeded. A great many analyses of early seeded (before December 20th) wheat as compared with late seeded (after January 25th) have conclusively shown that the former tends to produce a grain large in size, heavier in weight, lighter in color, a larger yield, and distinctly lower in gluten.

TABLE X.—RESULTS OF EARLY VS. LATE SEEDING OF GRAIN.

	1907-10 Wheat: 63 trials	1910 Wheat: 18 trials	Barley: 13 trials
Early seeding (before Dec. 20)	44.39 bu.	45.01* bu.	63.79 bu.
Late seeding (after Jan. 25)	40.32	42.05	48.90
In favor of early seeding	4.09	2.96	14.89
Percentage increase	10.14	7.04	30.5
Increased money value	$3.93	$2.84	$8.93

Wheat figured at $1.60 per cental; barley at $1 per cental.

* Seeded Dec. 20-25.

THE SELECTION AND TREATMENT OF SEED.

There would seem to be little necessity of discussing the importance of good seed, yet that comparatively little attention is given to this matter of seed selection is certainly indicated by the samples of seed-wheat which have been collected from farmers by the writer. Further, it is highly prejudicial to the highest results that there are numerous erroneous ideas, held very tenaciously, as to several points concerning seed-wheat. There is little doubt that much of the present condition of low yield is due to the lack of attention to the rational selection of first-class seed—*the best of seed is always the cheapest.*

It is certain that one of the factors which has tended to reduce the yield of wheat in California is the egregious blunder of constantly selecting small and shrunken grains for seed. If there is one thing that has been conclusively demonstrated by the most carefully conducted experiments, it has been the superiority of product, in both quantity and quality, obtained from the selection of large, vigorous heavy grains for seed. Numerous experiments, conducted both in

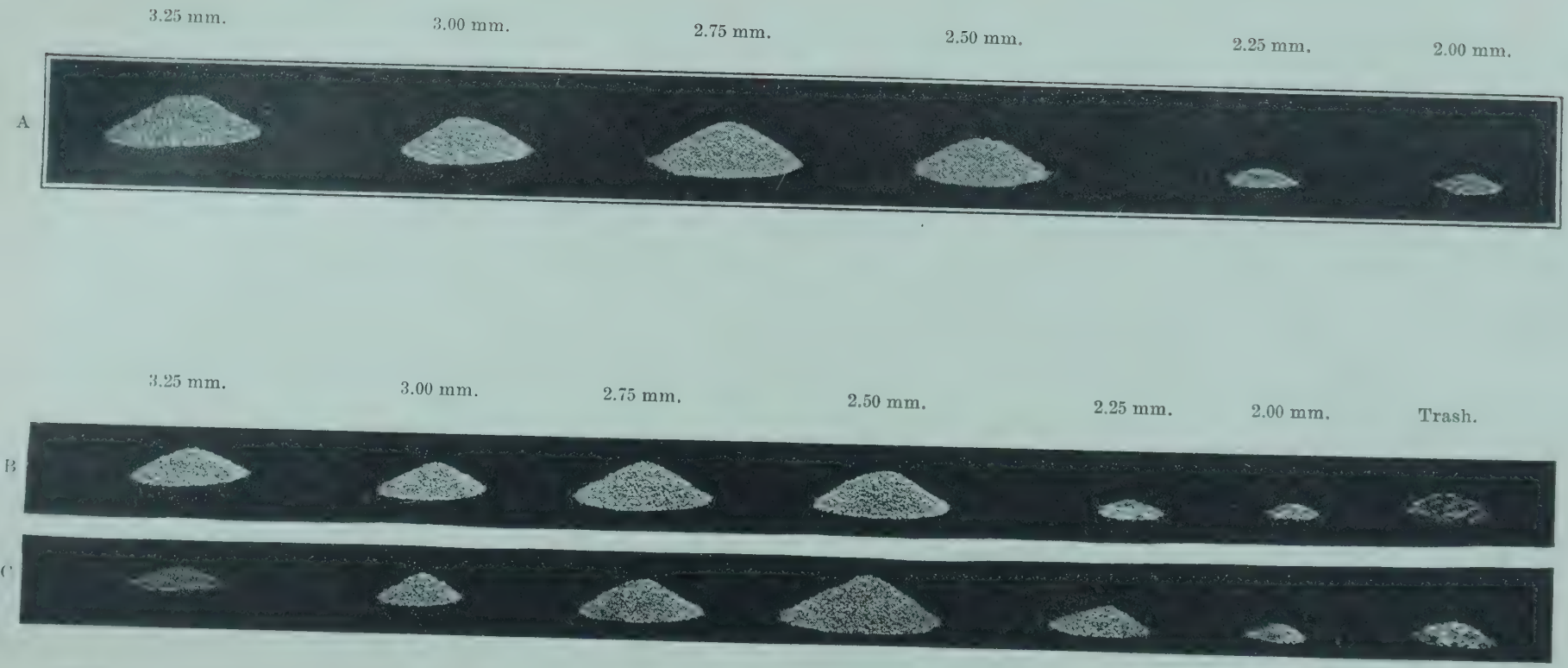


Fig. 15.—Comparing the average grading of (A) a standard sample of White Australian with (B) the best 25 per cent. of White Australian samples and (C) the average of all samples of the same variety.

this country and in Australia, not only with wheat, but also with corn and other grains, have so conclusively demonstrated this point as to render it beyond question, yet we find growers continually selecting the poorest of parental seed, thus gaining a constantly degenerating product, both as to quantity and quality. The sole idea seems to be to get the largest number of plants upon an acre of ground, irrespective of the fact that quality of grain as well as quantity makes for profit.

An attempt has been made during these investigations to gain a knowledge of the general character of seed being used by wheat growers. To this end, many samples of the common wheats about to be used for seed were secured from growers and sieve-graded upon an arbitrary basis for comparison against a typical lot of the same variety of wheat.

The samples collected for examination were obtained over a wide area in the Sacramento and San Joaquin valleys, the two great wheat-growing sections of the State, and probably fairly represent the general character of the seed used by the farmers of the State. The separations made are set forth below in tabular form, and when examined show a number of things of interest bearing upon the matter of the character of seed-wheat being used by the farmers of the State.

The figures are the results obtained by separating the several sizes of grains by means of a set of sieves with meshes of arbitrary size.

The results of such grading are shown in Fig. 14 and the following table:

TABLE VII.—COMPARING THE GRADING OF GOOD AND POOR SEED.

	1 3.25 mm. %	2 3.00 mm. %	3 2.75 mm. %	4 2.50 mm. %	5 2.25 mm. %	6 2.00 mm. %	7 Trash. %	Weight per bu. Lbs.
Standard	28.61	18.49	28.74	19.62	1.83	1.93	.75	60.5
Average of 25% of best samples	17.58	14.24	30.31	28.46	2.46	1.29	5.89	58.2
Average	6.56	8.23	22.16	47.20	9.74	2.19	3.84	57.7

From this it may be seen that there is room for much improvement in the grade of our wheat, even though no higher standard be taken than that used by the best one-fourth of the growers here represented; and if we should exclude from the average the best one-fourth the difference would be still more striking.

From the standpoint of practical work it may be argued that it is impossible to secure as high a grade as here represented by the standard, but it is certainly fair to assume that all can easily secure a seed which will grade as high as the average used by 25 per cent.

of the growers here represented. Special attention is called to this because it is a standard entirely possible for the wheat-growers to reach, and there is little doubt that the wheat crops would be much improved by such seed, and it is a plan that could be put into immediate operation. It is the worst kind of folly to continue to plant small, light seed when it is so easy to secure seed of good, if not of the very best, quality. No grower, however, should be satisfied with anything short of *the best* for seed, and by so much as he lowers his standard in this respect does he multiply his chances of failure. This is the more important since the climatic conditions which obtain in the wheat-growing sections of the State are decidedly fickle, particularly as to moisture and those conditions which lead to rust attacks. We should take every precaution to secure the best of seed—large, plump, and vigorous—but should remember that by far the better results can be obtained if we are also certain that the seed has come by selection from strong and vigorous plants.

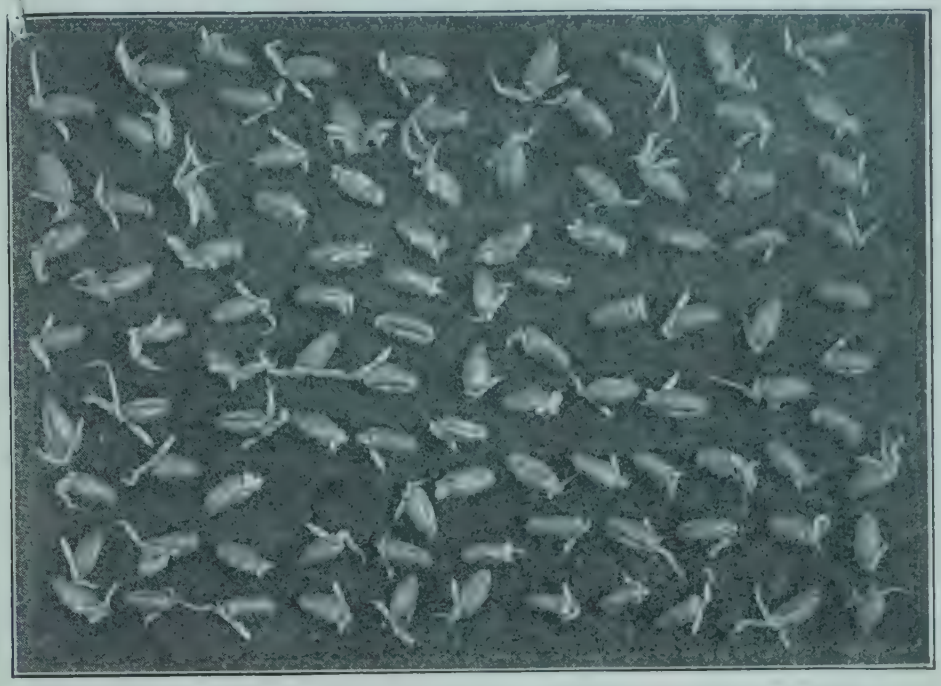
SELECT SEED FROM PRODUCTIVE PLANTS.

In connection herewith it should be stated that the highest results can only be obtained when the seed is selected from productive individual plants, and that under favorable conditions even small perfect seeds from productive plants may be better than large seeds from unproductive plants. The main influence of large grains selected by simple sieve grading will be in giving the plants a more vigorous start in life, which of itself is of extreme importance. Other things being equal, it is entirely fair to presume that the crops which are placed under the most favorable environment are going to give the best returns. It has been shown that, in general, the more vigorous plants (that is, those having the largest spikelets) contain the larger grains, so that even in selecting the grains by simple sieve separation the bulk of the larger grains would come from the more vigorous plants, and thus there would be, in a measure at least, a selection from vigorous plants.

LARGE AND PLUMP VS. SMALL AND SHRIVELED SEED.

A condition much to be deplored is the great tendency of growers to use small, pinched seed. It is not easy to give an accurate definition as to what is meant by shriveled seed, but Fig. 16 will serve to show the contrast between plump and shriveled seed as here discussed. Doubtless the entire discussion is due to the fact that extremely inferior looking seed will actually germinate and to a certain extent

grow and bear a crop, and *under favorable* conditions may even produce a good yield. This fact has unfortunately given rise to much



A

B

Fig. 16.—Showing the difference in the vigor of germination between (A) plump and (B) pinched seed-wheat.

carelessness in the selection of seed-wheat, which must be overcome if we are to secure the highest results in grain culture.

The main reason for the superiority of large, heavy grain for seed purposes is physiological, and lies in the larger reserve food supply in the larger seed. It has been shown that heavier seeds possess more

of the important plant foods (phosphoric acid, nitrogen, and potash).[1] These materials are the first nourishment which the plantlet gets; there is abundant material immediately available to the plantlet, and the young plant is soon in a position to take a vigorous hold upon the soil.

That the germination of such pinched seed is fair is indicated by a germination test which showed 92 per cent. of the grain actually germinated, but the plantlets were very weak, and undoubtedly their vitality would always remain low. (See Fig. 16.)

These results are in entire harmony with what we know as to the necessity of securing vigorous, plump seed in the case of alfalfa and other crops. The same fact is recognized by the farmer with reference to the parentage of his animals, but unfortunately the idea holds that the case is different with wheat.

CLEAN AND GRADE SEED WHEAT.

Small and pinched kernels, as well as weed seed, should be removed from grain that is to be used for seed purposes. There is no better investment for a grain grower than the purchase of a seed cleaner and grader. There are numerous good machines for this purpose on the market, among which may be mentioned the Owens Advance cleaner and grader, the Chatham Mill, and the Globe Separator and Grader; all of which we have had in use upon the Stations.

EFFECT OF CHANGE OF SEED.

There is a very widespread belief among grain-growers that there is a necessity for frequent change of seed because of actual deterioration due to continued culture under the same soil conditions. This idea is held to such an extent as to be well nigh universal. Yet, the most carefully conducted investigations, with scarcely a single exception, go to show that not only is there no benefit to be derived from the *mere change of seed,* but that actual loss occurs. In the light of these carefully conducted experiments we may safely lay down the principle that *unless the change be for the purpose of obtaining a better variety or a stronger seed* there can be no advantage resulting from a change of seed-wheat, and in case seed be purchased from a portion of the country where climatic conditions are quite unlike those of California the seed is not likely to be at its best for several years.

If seed shows signs of "running-out" it simply means that proper care has not been taken in the selection of the seed to remove small,

[1] A further discussion of the seed question may be found in Bulletin No. 181 of this Station.

shriveled, and light-weight kernels, and to use only plump kernels. *With proper care in the selection of seed, wheat does not deteriorate from any change within itself.* But to maintain the standard of yield *care must be taken in the selection of the best seed* and to practice rational methods of rotation, manuring, and tillage to maintain the fertility of the soil.

PREVENTION OF SMUT.

The grain smuts in California cause an annual loss in the crop of the State that may be conservatively estimated at over $1,000,000. Not only does this direct loss occur, but there is a further loss through a lowering of the commercial grades, which is occasioned by the presence of even a small quantity of smut on the grain. Farmers, doubtless, do not realize the large loss which occurs annually from this trouble. Its widespread occurrence in the State is the more to be deplored since the preventive methods which can be employed are both easy of application and extremely effective.

The smuts of grain are caused by the growth of minute parasitic plants that live within the tissues of the grain plants and are nourished by their juices.

While there are certain minor ways in which the disease may infect a field, the major amount of the infection in every case enters by way of the seed; therefore, the greatest care should be taken to so select, care for, and treat the seed as to prevent sowing living smut spores with the seed grain.

While there are two quite distinct classes of the so-called smuts which affect grain crops, one known as loose, or black smut, and the other stinking smut, or bunt, of wheat, it is the latter which causes by far the greatest loss in wheat.

On account of the fact that the spores may remain entirely inclosed in the wheat grain, and of the very disagreeable odor, it not only is capable of seriously reducing the yield, but also damages the quality of the associated sound grain when milled, by imparting a disagreeable odor to the flour.

METHODS FOR SMUT PREVENTION.

Since the major source of infection is through the medium of the seed, it is necessary that all seed sown be treated by such a process as will kill the smut spores adhering to the grain without injury to the latter. There are two methods which can be recommended as well nigh positive in result, when the seed has been properly treated.

These methods are set forth below in the order in which they are recommended.

Formalin Method.—Use one pound of formalin (a 40 per cent. solution of formaldehyd) to 50 gallons of water. The solution may be placed in barrels or tanks until used. The wheat may be dipped into the solution in loosely woven bags or wire baskets, allowed to remain for ten minutes, and then drained to save all the liquid possible, and dried, when it is ready to sow.

If it is preferred, the seed may be spread on a clean canvas or board floor and the formaldehyd solution applied with a sprinkler, or hose and nozzle, constantly stirring and mixing the grain with a rake or shovel until all the kernels are thoroughly wetted, when it is allowed to dry.

Be sure to get 40 per cent. formalin. Dealers sometimes give a 25 or 30 per cent. formalin for a 40 per cent.

The formalin should be weighed in order to make sure that a full pound to each 50 gallons of water be used. The cans in which the formalin comes often contain only three-fourths of a pound, hence the necessity of this precaution.

This treatment has an advantage over some others, in that it is not poisonous to persons handling the material.

A Machine for Treating Wheat to Prevent Smut.—Of late there has come on to the market a machine for the formaldehyd treatment to prevent smut. It is a very efficient arrangement for this purpose since it insures the thorough wetting of each kernel and at the same

Fig. 17.—Machine for formalin treatment to prevent smut on grain.

time removes by means of a scraper wild oats, light seeds, and unbroken smut balls. An illustration of this machine is shown in Fig. 17. The seed is poured into the hopper and fed into the formaldehyd solution contained in the tank below. It passes loosely through this solution and is conveyed by the elevator to a fresh sack or box. The skimmer is one of the most important parts of the machine, for it removes from the surface of the solution all the unbroken smut balls, wild oats, and light trash which float on top.

In treating oats the action of the skimmer is reversed so the grain is forced in front of the return carriers, and by them into the bottom of the treating tank, then elevated as wheat.

Bluestone, or Copper Sulfate, Method.—This is the method practiced almost exclusively in California. Its lack of effectiveness in many cases may generally be traced to a lack of thoroughness in the work, or to re-inoculation of the seed in some manner after treatment.

A solution is made by dissolving 1 pound of blue vitriol in 4 gallons of cold water, and dipping the wheat in the solution, as above, until the grain has become thoroughly wetted, after which it is immediately dried. Or the wheat may be piled upon a floor or canvas, and thoroughly sprinkled or sprayed with the solution while the grain is being constantly shoveled over so that every grain becomes wet over the entire surface. Care should be taken that the solution is of uniform density by thoroughly agitating just previous to use.

EFFECTIVENESS OF TREATMENTS FOR SMUT PREVENTION.

To ascertain the relative effectiveness of several methods of treatment and more particularly to test the effectiveness of dilute sulfuric acid for the prevention of stinking smut, in the season of 1909 comparative trials were made of the well recognized fungicides, bluestone, and formaldehyd, also a proprietary preparation known as Anti-fungi, and two different dilutions of sulfuric acid.

In this trial five varieties of wheat were employed and one of barley. About three pounds of smut-free seed of each variety were thoroughly infected with stinking smut by shaking the seed with a quantity of the powdered smut balls. The solutions were made up according to the strengths indicated in the tabular statement subjoined, and a separate portion of each lot of wheat immersed in each of the solutions, one portion being reserved for planting untreated to serve as a check. The results are tabulated below:

TABLE VIII.—RESULTS OF TREATMENT TO PREVENT SMUT IN GRAIN, 1909.

CLEAN SEED INOCCULATED WITH SMUT SPORES.

	Per cent. smutted plants at harvest					
Name	Untreated	Bluestone 1 lb to 4 gals.	Antifungi 1 lb. to 2½ gals.	H_2SO_4 1-1000 by wt.	H_2SO_4 1-500 by wt.	Formalin 1 lb to 50 gals.
White Australian	75.2	0.19	1.23	60.66	16.47	29.07
King's Early	62.4	1.30	1.15	59.25	58.54	13.50
Chul	48.8	0.00	2.36	59.91	19.32	28.62
Velvet Don	45.5	0.00	0.17	49.92	5.30	16.80
Sonora	16.7	0.18	0.00	52.74	0.32	0.00
Average	49.7	0.33	0.98	56.49	19.99	17.29
BARLEY.						
Common California	56.3	0.00	0.00	11.00	0.58	0.00

It will be noted that while practically 50 per cent. of the grain from the untreated seed was destroyed by smut, only one-third of 1 per cent. of the "bluestoned" seed was lost. This shows the well recognized effectiveness of this treatment. The "Anti-fungi" treatment was very effective, the loss in this case being a trifle less than 1 per cent.

Sprayed. Unsprayed.

Fig. 18.—Showing effect of spraying with iron sulfate to kill mustard.

The 1-1000 sulfuric acid solution was far too weak to be of value, but the stronger acid solution (1 to 500) was nearly as effective as the formalin and is probably worth further trial.

It is further quite evident that certain varieties of wheat are much more smut-resistant than others, and that White Australian is very susceptible to the fungus.

SPRAYING TO KILL WEEDS.

In 1905-06 some experiments were made to test the effect of spraying the plats at Yuba City with a solution of copper sulfate to kill the wild radish. The results were not very satisfactory as a whole. In many of the plats the weeds were so large that even one hundred gallons per acre of the solution would not cover the weeds sufficiently to kill them. In cases where very small plants were

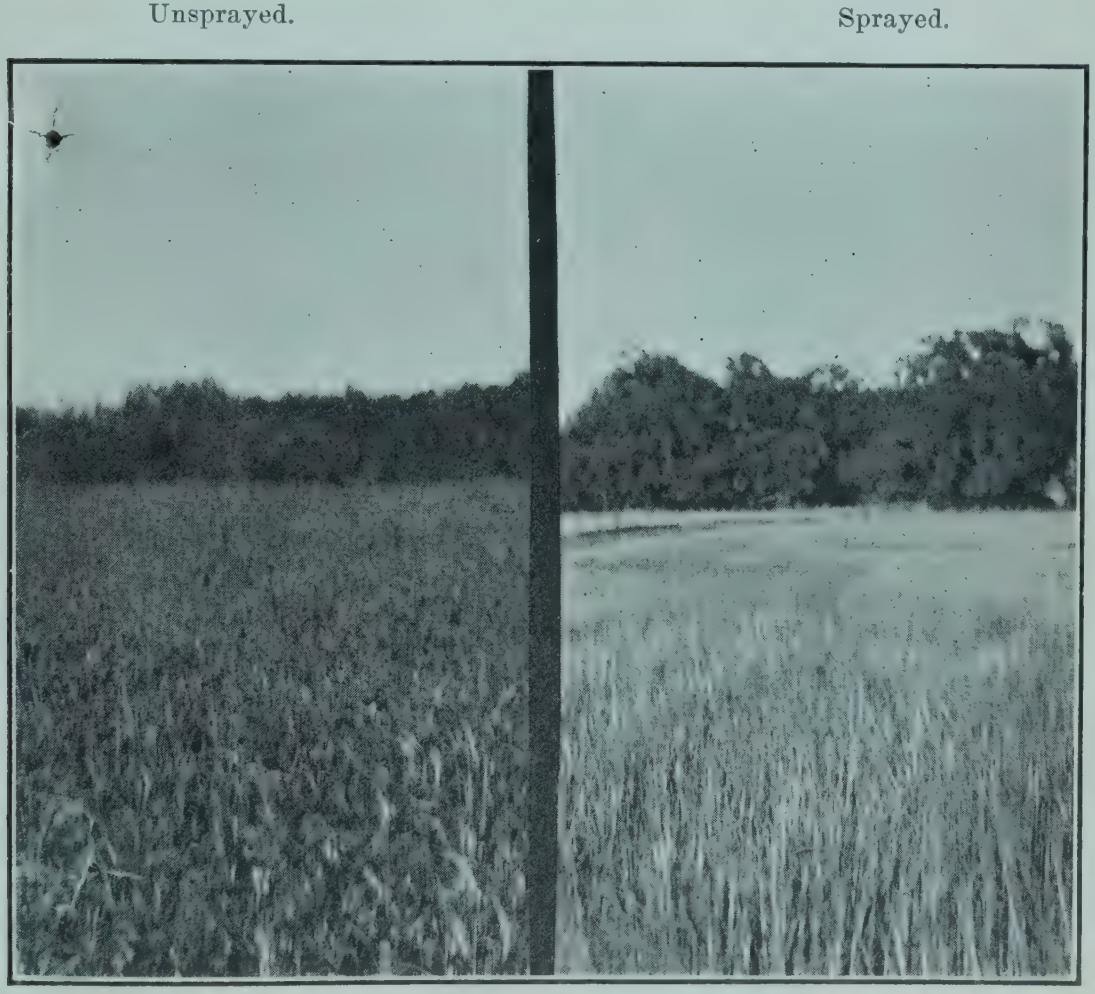


Fig. 19.—Showing effect of spraying with iron sulfate to kill mustard.

sprayed the weeds were killed, but the land was so infested with seed that every shower caused more plants to grow. A solution of one pound of copper sulfate to two gallons of water and applied at the rate of about one hundred gallons per acre proved effective in killing young plants of the mustard and radish, besides various other weeds, without resulting in permanent injury to any of the cereals. In some cases the upper portion of the blades turned brown at first, but growth was not retarded materially, and in a week or ten days the plants had resumed their usual green color. Experiments in spraying to kill weeds in grain fields were taken up again in 1908-09. In these trials iron sulfate was used instead of copper sulfate and with more effective and more economical results. The details of the several trials made will not be set forth at this time, but suffice it to say that the trials showed the effectiveness of this treatment for the killing of mustard, but it did not prove effective for killing radish. In these trials the iron sulfate was used at the rate of 140 pounds per acre. In general, it may be said that about 65 per cent. of the mustard was killed by one application of this spray. However, the present freight rates upon this iron sulfate renders it prohibitive to use the material on a large scale, as much as it is needed in some sections of the state.

CHARACTERISTICS OF WHEATS DESIRABLE FOR CALIFORNIA.

Considered only in relation to field conditions there are certain special characteristics which are extremely desirable for wheats which are to be introduced into this State. The following are considered the most prominent of these: manner of growth, tenacity, days to mature, character of head (especially with respect to awns), rust resistance, and heavy yielding plants.

In the selection of a variety, climatic, and soil conditions must be given consideration, for certain varieties are more suitable for light soils than for heavy soils, and vice versa. Further, some varieties are much more able to withstand drought than others. This latter condition is of special significance under "dry farming" conditions. Further, there is considerable difference in the ability of varieties to withstand attacks of rust, which, in the coastal regions, is a factor of much importance; in the interior section, however, this is of less consequence.

EARLY MATURITY.

Earliness, as measured by days to mature, is an important point for consideration in the selection of grains for use in California. The wheats should be such as can be planted as late as possible and will have a rapid growth and mature early, before the exceedingly hot weather comes on in the summer. Further, earliness is a great factor in enabling the wheats, and grains in general, to withstand rust attacks, which are very severe in certain sections. This is extremely important for wheats grown in the coast counties, for in that region rust is an omnipresent difficulty, owing to the more moist atmosphere. Further, the early wheats are not as apt to be injured by drought as the later maturing varieties.

HABIT OF GROWTH.

The manner of autumn growth (that is, whether the growth is upright or spreading) is of unusual importance under the present condition of the grain fields as to weeds. Until the farms are in a much cleaner condition than at the present time no wheat is likely to meet with favor unless it will make a reasonably good fight for life among weeds. This factor is not so important in the case of wheats used on summer-fallow land, but in many instances even in this case, it is of some importance, because the continued use of the combined harvester, coupled with generally careless methods, have so seriously scattered the weeds in the grain fields as to make even the summer-fallow land exceedingly foul. In such fields the plants that have a low-spreading growth in the fall and winter have but little chance against the weeds. It is the strong upright growth made by the varieties commonly grown in the State that has been one of the main factors which has enabled them to hold their own in the State despite their low milling qualities. This rapid upright growth enables them to successfully keep ahead of the weeds and finally win in the race. With the farms becoming smaller and being given greater care, and the introduction of the binder, this factor possibly will not be as important. Generally speaking, however, these same spreading varieties require early planting, and for this reason under the conditions of precipitation which hold in large grain-growing sections of the State it is difficult to get them planted, except on summer-fallow land, sufficiently early to have them under favorable conditions for good yield. They must be growing by December 1st to be under even fair conditions, and it is seldom, indeed, except

on summer-fallow land, that it would be possible to seed by that date. This will be one of the greatest obstacles in the introduction of these wheats into this State. *Our present idea is that varieties whose early growth is of a spreading character are not well suited to the climatic and other conditions which obtain in this State generally,* unless it be in those parts of the State where limited areas of wheat are grown

Seeded Dec. 6. Seeded Jan. 15.

Fig. 20.—Showing necessity of early planting for spreading winter wheats. Both plats same variety of wheat. Photographed May 1st.

by irrigation, where a late summer or early fall irrigation can be given the land, thus enabling it to be put into condition earlier than otherwise would be possible. Such varieties may, however, be suited to the smaller valleys in the mountain sections of the State.

TENACITY, OR NON-SHATTERING HABIT.

The tenacity with which the chaff holds the grain is also an especially important factor in California, where the combined harvester is so extensively used. Grain frequently stands in the field

for a month to six weeks after it is mature, and under the heavy winds which prevail in the Sacramento Valley, and certain parts of the San Joaquin Valley, unless the chaff is very tenacious of the berry there is serious loss. With the use of the self-binder instead

Fig. 21.—Showing typical heads of different classes of wheats, one-half natural size. A, beardless common wheat, White Australian; B, bearded common wheat, Turkey Red, a spreading winter wheat; C, bearded durum wheat, Kubanka.

of the combined harvester this loses something of its significance, but it will always be a factor of importance. The wheats which have survived in the struggle for existence here have been of this character, and it is one of the principal points in which the Little Club variety appeals to the farmer, and out-weighs the undesirable points of this wheat.

CHARACTER OF HEAD.

The character of the head as to awns is of greater importance than in most places, because it is a custom here, and one which the fickleness of the climate renders almost necessary, for farmers to be governed largely by the character of the season as to whether the crop is allowed to mature its grain or whether it is cut for hay. If the season seems to be unpropitious for the maturing of a fair crop of grain it will be cut before maturity for hay. Thus, an awnless variety is much preferable.

MILLING QUALITY.

Perhaps no factor in the selection of a variety is of greater importance in California than that of the milling quality. Practically no flour is made today anywhere from wheats milled of one variety alone. Practically all flour is the result of a blend of varieties. On account of the low gluten content of the type commonly grown in California an undue quantity of wheat has to be imported from Kansas and other points to build up the gluten content of the manufactured flour to a sufficient quantity and quality. It is highly desirable to find and introduce varieties that will lessen these importations. The milling value of a wheat is judged by both the quantity and quality of the flour product. The quality of the flour for baking is determined by its gluten quantity and quality, and its color. It is highly essential that varieties be grown which will produce more and better gluten per acre.

OTHER REQUISITES.

The importance of high yielding plants is too evident to need any discussion. No other characteristic of a plant is so important, and most of those mentioned above have a bearing upon this quality.

The possession of a stiff or weak stem, and resistance to bunt, are all factors that should be considered by the grower.

SEED IMPROVEMENT BY THE GROWER.

The farmer can do much toward the improvement of his own seed by attempting to bring it to a high standard of perfection and purity of variety by proper methods of selection and culture, which is far preferable to the constant and indiscriminate change of seed practiced by so many. It has long been the practice of farmers to make a sort of selection of seed corn, and to some extent of seed potatoes, but the fact that seed grain is as capable of improvement by such selection

seems to have been well nigh overlooked. The practice of indiscriminate seed exchange precludes the possibility of any permanent crop improvement by careful culture and seed selection. While the farmer can not follow out the details of plant breeding, yet it is entirely feasible for him to practice with his own crops straight selection of seed.

Fig. 22.—Seed selection plats, University Farm, Davis.

MAINTAIN A SEED PLAT.

The maintenance of a seed plat for the improvement of seed should be the practice of every grain grower in California. This plat should be located at different parts of the farm every two or three years. The location should always be where the soil is of uniform quality, but one should avoid areas of special fertility. It is important that the seed plat should be located on *clean* land, and particular care should be taken that the land be free from other varieties of grain. It is best, then, that the land should have been under clean culture the preceding year, or that some cultivated crop should have been grown in the preceding year. Just before harvest go through a field of a good, hardy, standard variety that has given the best results in the locality and mark plants that exhibit to the highest degree the

special quality which it is desired to increase, such as freedom from rust, fertility of head, or otherwise, and which are at the same time at least as good as the average in other respects. At harvest time cut with a sickle enough of these marked plants for sowing the plat, and, after threshing them, select the largest and most vigorous seed for this purpose by means of a screen, or, preferably, gravity grader. Sow the plat early, drilling it at the average rate of about 80 pounds per acre. From this seed plat select as above seed sufficient to reseed a similar plat the following season, and harvest and thresh the remainder of the crop from the seed plat separately from the main crop, care being taken that the machinery used is free from all other grains which might cause a mixture. The first portion threshed should be rejected, as it is most likely to contain such a mixture. The grain from the seed plat should be used, as far as it will go, for the general crop the succeeding year. If there is a considerable acreage it may be necessary to continue the seed plat for a second year in order to obtain sufficient seed for the main crop. In this way seed is never taken from the general crop, which can not be given the same care as the small plat, and there is a constant selection of seed, which is more and more rigid every year. Moreover, there is no extra labor involved, except the small amount required for seed selection each year.

VARIETY TESTS.

A large number of variety tests of wheat have been conducted by the University during the past five years, but very few of them have shown characteristics thoroughly adapted to California conditions. The variety tests have not yet been conducted for a sufficient time to enable a positive statement to be made as to the adaptability of all of these varieties in any particular locality. There is probably *no one best variety* even for one section. Varieties which produce good yields in one section are found to give poor returns in other section. Some varieties do better on heavy soil, others on light soil. *Further work needs to be done concerning a wider variety of conditions.* However, the work already done indicates that there are a number of varieties that will probably meet the prevailing conditions better than the commonly grown wheats.

In the following tables the results of variety tests are shown. The wheats are classified as the spreading winter types, the upright spring types, the durum types, and the hybrids which have shown promise.

TABLE XI.—SHOWING AVERAGE YIELD OF WHEATS OF THE SPREADING TYPE AT MODESTO AND CERES, 1907-10.

C. I. No.	Variety	Av. number of days maturing	Av. number days in fruiting period	Non-shattering character	Av. yield per acre—Variety	Av. yield per acre—Check
2210	Cap Sheaf	168	38	Fair	24.7	48.4
1437	Crimean	176	35	Fair	26.5	31.8
2988	Dietz Amber	167	37	Fair	15.7	22.1
2398	Galgalos	168	37	Good	32.3	34.3
1442	Kharkov	170	29	Fair	30.1	32.3
2989	Jones' Fife	178	36	Fair	23.1	26.0
2873	Glyndon	178	35	Fair	18.1	26.0
1561	Theiss	176	36	Fair	19.8	28.9
	Rice	165	.....		19.7	48.4
1558	Turkey	173	39	Fair	32.1	30.3
	Gold Coin	172	33	Fair	15.3	29.3
2592	(Unnamed)	180	40	Fair	41.0	41.2

Generally speaking, the wheats of spreading type have not equalled the upright growing varieties, and they are not well adapted to the conditions in the large wheat growing areas of the State, although they may be adapted to some of the smaller valleys in the northern part of the State.

The United States Department of Agriculture hybrids, and also those from Kansas, are practically all of this type. Some of these have made excellent showing in the matter of yield, but they deteriorate in quality quite easily. It is very doubtful whether they can ever be made highly desirable wheats for California. A tabulation of the results with the hybrids of this type is shown below:

TABLE XII.—TABLE SHOWING AVERAGE YIELD OF HYBRID WHEATS, 1908-09.

Hybrid Number and Cross	Av. number of days maturing	Av. number days in fruiting period	Non-shattering character	Average yield
1406 x Mediterranean, 31a7-1-1-1-1-1-1-1-1..	168	40	Fair	37.7
1406 x Mediterranean, 31a9-1-1-1-1-1-1-1-1..	168	39	Poor	59.9
1406 x 1405, 32a4-1-1-1-1-1-1-1	168	39	Fair	38.7
Dawson's Golden Chaff x Jones' Winter Fife, 35a2-1-1-1-1-1-1-1	168	40	Fair	47.1
Turkey x Extra Early Oakley, 350a4-1-1-1-1-1-1-1	168	40	Poor	40.9
Turkey x Extra Early Oakley, 350a5-1-1-1-1-1-1-1	168	40	Poor	39.7
Turkey x Extra Early Oakley, 350a6-1-1-1-1-1-1-1	168	40	Poor	46.1
Red Winter Fife x (Onigara x 1344), 351a2-1-1-1-1-1-1-1	168	36	Fair	48.7

Hybrid Number and Cross	Av. number of days maturing	Av. number days in fruiting period	Non-shattering character	Average yield
Sea Island x (Yemide x Dawson's Golden Chaff), 362a3-1-1-1-1-1-1-1	170	37	Fair	46.5
Sea Island x (Yemide x Dawson's Golden Chaff), 362a4-1-1-1-1-1-1-1	170	37	Poor	43.8
Sea Island x Polish 366a-1-1-1-1-1-1-1	170	37	Fair	50.2
Currel x Banat, 1803-2	171	37	Poor	44.7*
Andrew's No. 4 x Zimmerman, 1806-2	171	37	Very poor	34.7*
Weissenberg x Currel, 1807-1	171	37	Fair	42.7*
Red May x Banat, 1808-1	164	32	Fair	49.0*
Penquite's V. C. x Zimmerman, 1823-1	175	40	Fair	30.0*
German Emperor x Turkey, 1832-2	175	41	Fair	23.3*†
Penquite's V. C. x Zimmerman, 1833-3	171	37	Fair	10.7*†
Dawson's Golden Chaff x Turkey, 1850-2	175	41	Fair	5.3*†
Banat x Turkey, 1860	175	39	Fair	3.3*†

* One year only (1909).

† Soil very light and poor.

The following table (XIII) shows the characteristics and average yields of wheats of the erect growing type, together with the average yield of the check plats of White Australian grown under the same conditions at Modesto and Ceres:

TABLE XIII.—SHOWING THE AVERAGE YIELD OF WHEATS OF THE ERECT GROWING TYPE AT MODESTO AND CERES, 1907-10.

C. I. No.	Variety	Av. number of days maturing	Av. number days in fruiting period	Non-shattering character	Av. yield per acre—Variety	Av. yield per acre—Check
1698	Allora	161	45	Good	38.1	41.1
3019	White Australian	169	38	Fair	32.6	.....
2511-2	Blenoir	155	39	Fair	48.1	48.7
2921	Bolo Blanco	169	46	Good	51.4	41.8
2986	California Gem	165	38	Fair	29.1	32.6
2227	Chul	166	41	Excellent	41.7	34.7
3018	Club	158	41	Good	29.9	30.5
2397	Erivan	169	35	Good	40.6	36.1
1697	Early Baart	159	38	Fair	24.6	22.8
1596	Fretes	169	42	Fair	46.5	36.6
2888	Filippino	172	38	Very good	30.9	35.9
1970	Propo	164	42	Fair	37.3	33.2
2991	Purple Straw	161	35	Fair	45.0	49.8
2984	Saumaur de Mars	172	37	Poor	38.9	37.6
2983	Chiddam	172	38	Poor	38.4	37.6
2899	Chul (selection)	139	36	Very good	33.3	29.9
1743	Sonora	158	44	Fair	34.8	35.2
2985	W. Bluestem	176	36	Fair	21.8	30.3
	Bobs	145	43	Fair	45.4	40.3

DURUM WHEATS.

The durum types of wheat have proven to be quite erratic producers both in quantity and quality of product. All the durum varieties have an upright growth. The performance of a number of the more promising ones at Ceres is shown in the tabulation below:

TABLE XIV.—SHOWING AVERAGE YIELD OF DURUM WHEATS, 1908-09.

C. I. No.	Variety	Av. number of days maturing	Av. number days in fruiting period	Non-shattering character	Yield per acre: bu. 1908	1909	Average
1593	Marouani	164	41	Good	12.8	36.8	24.8
2235-2	Marouani	162.5	39.5	Fair	46.7	33.3	40.0
2096	Yel. Gharnovka	164	40	Good	31.8	18.0	24.9
2221	Kubanka	164	40	Good	26.8	26.5	26.6
2246	Kubanka	164	39.5	Good	30.8	21.8	26.3
2247	Velvet Don	164	39.5	Good	32.8	14.2	23.5
2537	Marchand	167.5	40	Fair	32.6	14.0	23.3
2545	Semonlier	167.5	40	Fair	41.6	18.0	29.8
2547-2	(Unknown)	167.5	40	Fair	52.9	18.7	35.8

Fig. 23.—White Australian wheat, 1908, at University Farm, Davis.

TABLE XV.—SHOWING YIELD OF WHEATS AT TULARE STATION, 1907-09.

Cal. No.	Variety	Manner of early growth	Av. number of days maturing	Av. number days in fruiting period	Non-shattering character	Yields at Tulare: bu. per acre			
						1907	1908	1909	Av. 3 yrs.
1003	Dawson's Golden Chaff	Spreading	177	44	Fair	35.3	32.0	31.0	32.7
989	Fultz*	Spreading	172	41	Fair	34.3	48.6	18.6	33.8
993	Crimean	Spreading	176	45	Fair	35.3	47.2	28.0	36.8
994	Pesterboden	Spreading	179	41	Fair	28.0	56.0	31.4	38.5
991	Beloglina	Spreading	180	43	Fair	34.0	38.6	30.3	34.3
992	Kharkov	Spreading	183	45	Fair	12.6	44.6	20.0	25.7
990	Theiss	Spreading	172	46	Fair	42.0	56.0	31.0	43.0
1002	Gennesee Giant	Spreading	169	40	Fair	22.1	30.0	18.6	23.6
1001	Clawson's Longberry	Erect	171	27.5?	Fair	20.7	35.6	15.2	25.5
1004	Allora	Erect	155	46	Good	30.6	47.1	22.3	33.3
1000	King's Early	Erect	157	46	Fair	32.4	52.6	22.1	35.7
1005	Fretes	Erect	160	49	Fair	.....	58.3	28.9	43.4
988	Fultz†	Erect	179	45	Fair	35.9	52.0	38.6	42.2
907	(Unknown)	Erect	.....	....	Good	50.4	65.3	26.9	47.5
480	Propo	Erect	169	39	Fair	44.6	45.0	36.0	41.8
459	Little Club	Erect	160	40	Good	30.7	51.3	20.0	34.0
466	California Gem	Semi-erect	169	41	Fair	42.5	45.7	10.3	32.7
483	Thibet	Erect	145	43		.....	32.0	13.3	22.6
1009	Galgalos	Spreading	160	40	Good	.....	38.6	26.6	32.6
998	Chilean	Erect	147	44	Good	52.3	46.6	35.0	44.6
1008	Glyndon	Spreading	170	39	Fair	.....	32.0	32.0	32.0
1010	Saumaur de Mars	Erect	.....	....		.....	30.0	22.6	26.3
1007	Capetown	Erect	161	40	Fair	.....	57.2	29.3	43.6
996	Black Don	Erect	165	45	Good	29.0	38.0	29.3	33.6
995	Kubanka	Erect	147	45	Good	22.0	42.6	33.0	37.8
997	Kahla	Erect	178	42	Good	.....	36.9	42.8	39.8
954	Early Baart	Erect	165	52	Fair	.....	47.2	32.0	39.6
481	Sonora	Erect	156	47	Fair	.....	59.0	27.5	43.2
1011	Chul	Erect	163	45	Excellent	.....	29.0	33.3	31.3
107	Vol Korn		.....	....		.....	.....	29.0	29.0
820	Bolo Blanco	Erect	139	40	Good	.....	.....	54.0	54.0
452	White Australian	Erect	168	44	Fair	30.0	44.2	25.4	33.2

* Beardless.

† Bearded.

TABLE XVI.—SHOWING AVERAGE YIELD OF WHEATS OF THE ERECT-GROWING TYPE AT DAVIS, 1907-10.

		Av. yield per acre, bushels — Seeded before Dec. 20th		Seeded after Dec. 20th		Grand average		Average per cent. of Check yields
		Variety	Check	Variety	Check	Variety	Check	
2397	Erivan	46.6	60.2	38.6	49.6	42.6	54.9	77.6
1698	Allora	33.8	55.2	13.6	45.8	30.3	48.9	61.9
2986	California Gem	43.5	59.2	47.8	58.3	45.8	55.6	82.3
955*	Defiance	38.0	58.0	42.8	56.1	41.6	56.5	73.6
2985	Bluestem	38.3	55.2	54.5	53.8	49.1	54.2	90.6
793*	Japhet	40.3	63.3	41.6	44.4	41.4	47.1	87.9
1596	Fretes	47.3	44.8	35.8	34.5	42.7	40.7	104.9
1746	King's Early	45.7	41.7	38.1	35.0	41.7	38.4	108.6
2899		36.4	42.2	38.8	34.6	37.6	38.4	97.9
779*	Bobs	31.7	42.9	40.6	41.5	35.3	42.4	83.4
1697	Early Baart	49.0	43.8	42.6	39.6	45.8	41.7	109.9
3018	Little Club	55.1	49.3	42.4	42.8	47.5	45.4	107.0
2983	Chiddam	34.3	56.6	39.9	37.5	37.1	47.1	79.0
1970	Propo	48.7	49.3	49.1	47.1	48.9	48.0	101.9
2984	Saumaur de Mars	50.6	58.0	36.3	32.7	39.8	41.5	96.1
2227	Chul	42.4	42.8	35.8	38.3	39.1	40.5	98.9
1743	Sonora	46.2	47.5	45.2	30.5	45.9	41.8	91.2
1131*	Silver King	46.8	50.3	.....	.....	31.2	45.5	68.6
1732	Fishhead	33.7	37.0	43.2	30.5	38.4	33.7	113.8
1132*	White wheat	50.9	48.1	.....	.....	50.9	48.1	105.8
2511-2		48.0	33.2	45.2	36.0	46.6	34.6	134.7
1133*	Cumberland	53.0	38.2	46.2	30.5	49.6	34.3	144.4
2126-2	Kurd	39.0	37.5	41.8	30.5	40.4	34.0	137.0
2200-2	Karun	30.5	37.5	39.2	30.5	34.8	34.0	102.6
2794	Robeiro	47.0	45.1	50.3	28.5	48.0	39.5	124.0
2592	(No name)	36.7	33.2	.....	.....	36.7	33.2	110.5
2074	(No name)	40.3	42.3	.....	.....	.....	.....	95.2
2921	(No name)	35.2	33.2	.....	.....	.....	.....	106.0
2404	(No name)	32.7	33.2	.....	.....	.....	.....	98.5
1593	Marouani	42.9	44.0	49.4	37.6	46.1	40.8	113.1
2235-1	Marouani	46.9	49.5	39.7	36.7	44.5	45.2	98.5
1494	Arnantka	46.6	42.0	21.5	38.7	34.0	40.3	84.1
1595-1	Kahla	51.7	50.1	47.1	36.7	50.1	40.5	123.7
2096-1	Yellow Gharnovka	42.4	43.6	27.2	44.9	31.0	45.6	69.5
2247-1	Velvet Don	51.5	52.0	35.0	43.4	43.5	47.7	90.6
2247-2	Selection	52.3	52.1	37.6	45.0	45.0	48.5	92.7
2089-1	Richi	45.4	46.5	35.3	28.5	42.0	40.5	103.7
1440	Kubanka	46.1	58.9	38.7	36.1	40.5	41.8	96.9
8232	Black Don	45.3	59.6	30.9	48.9	38.1	54.2	70.3
2804	(No name)	53.1	45.3	39.2	28.5	48.4	39.7	122.0
2805	(No name)	47.7	44.6	48.8	28.5	48.0	39.3	122.4
2808	(No name)	60.8	45.3	42.1	29.0	54.5	39.9	137.0
2816	(No name)	57.6	45.3	35.7	29.0	50.3	43.2	116.4
2817	(No name)	71.1	47.0	.....	.....	71.1	47.0	151.1
2797		59.7	47.5	44.5	28.5	54.6	41.1	132.7

* California number.

TABLE SHOWING AVERAGE YIELD OF WHEATS OF SPREADING GROWTH IN SACRAMENTO VALLEY, 1907-10.

C. I. No.	Variety	Av. number of days maturing	Av. number days in fruiting period	Av. yield per acre, bushels: Seeded before Dec. 20th, Variety	Seeded before Dec. 20th, Check	Seeded after Dec. 20th, Variety	Seeded after Dec. 20th, Check	Grand average, Variety	Grand average, Check	Average per cent. of Check yields
1558	Turkey	167	40	32.3	54.0	24.6	44.3	22.3	49.2	45.4
582*	English Master	182	33	24.0	46.7	.....	.....	24.0	46.7	51.1
1438	Ghirka	166	42	37.6	50.9	29.2	39.6	20.9	44.2	47.2
1439	Ultra	161	40	34.6	50.9	14.7	37.8	22.6	43.1	52.5
1923	Fultz	158	41	32.9	50.0	.....	41.5	19.7	45.9	42.9
2873	Glyndon	178	44	40.9	50.4	43.5	50.5	42.0	50.4	83.1
2398	Galgalos	154	47	40.5	37.7	35.6	38.4	37.6	38.2	98.4
1356	Theiss	160	39	17.3	39.3	.....	.....	17.3	39.3	44.0
1437	Crimean	153	38	32.1	39.3	2.7	40.2	21.8	40.8	53.5
1442	Kharkov	162	40	35.2	50.9	11.3	44.0	27.3	48.6	56.2
782*	Fulcaster	154	37	18.3	39.3	.....	.....	18.3	39.3	46.6
2988	Dietz Amber	172	41	33.1	41.8	.....	42.1	13.3	42.0	31.5
1564	Pesterboden	143	38	19.3	50.0	9.3	49.0	14.3	49.5	28.8
784*	Powers' Fife	159	40	.....	.....	10.6	55.2	10.6	55.2	19.2
2239	Beloglina	181	44	22.4	50.0	.....	55.2	11.2	52.5	20.3
1127*	Hybrid 14a2 x c.	.....	....	44.2	44.2	.....	.....	44.2	44.2	100.0
1128*	Hybrid 362a3	.....	....	48.3	49.0	.....	.....	48.3	49.0	99.8

* California number.

Fig. 24.—Chul wheat, natural size.

SOME PROMISING NEW VARIETIES OF WHEAT FOR CALIFORNIA.

Of the many varieties of wheat tested during the last five years, the following varieties have shown the most promise and are recommended for trial by California farmers.

CHUL WHEAT.

Origin and History.—This wheat was first brought to this country by Mr. E. A. Bessey for the office of Seed and Plant Introduction in 1902. The University secured the first seed from this source. Of this variety the following notes were made by Mr. Bessey:

"Chul is grown on the steppes of Russia without irrigation. The grains are hard, but it is not durum wheat. This variety yields two harvests a year, for it can be sown as either a winter or spring wheat. If the former, the harvest comes in July; if the latter, the harvest comes in September. If sown in the spring, it is sown just as soon as the snow melts. The spring sowing is most certain to yield a good crop, for the fall sowing must depend upon the rather uncertain snows. This seed, however, is from the fall-sown seed. It is selected from over 1,000 pounds offered for sale, and is remarkably clean and free from foreign seeds for this region."

The Station distributed its first seed of this variety to farmers in October, 1903. The reported yields from these plantings were about 20 bushels per acre. Most of these small seedings were lost from one cause or another.

With the establishment of the Cereal Stations under the control of the University in 1904 and 1905 this variety was put into the variety test with others. From these stations small lots of Chul have been sent out from time to time to reliable farmers to further test its adaptability.

As a result of these experiments conducted upon the University Farm at Davis and at other stations, the University is now ready to recommend the wide planting of Chul (California No. 598) wheat, especially in place of Club and Chili wheats in the Sacramento Valley. After a number of years' trial, both on the experimental grounds controlled by the University and in co-operation with many farmers, this wheat has been found to meet the extreme conditions of the Sacramento Valley exceedingly well, besides being of milling quality much superior to Club but probably not superior to White Australian. While the wheat is of the bearded type, yet it differs much from the other bearded wheats which California farmers have tried.

Description.—Chul wheat is an early, erect, and vigorous variety which grows to a height of three to four feet. The wheat stools well

Fig. 25.—Little Club wheat at University Farm, Davis.

Fig. 26.—Chul wheat at University Farm, Davis.

and produces heads which are medium long, tapering, and bearded. In appearance, the growing wheat plant much resembles the well-known Propo, but the berry is of a much different character, being darker and larger, as well as harder. One particularly desirable feature is its non-shattering character. It will stand the heavy winds of the Sacramento Valley with scarcely any loss from shattering. The kernels are large, long, and tapering, and of a translucent character. The kernels are much harder and heavier than White Australian. They resemble the kernels from the durum wheats, although *the wheat is not a durum.* As indicated in the original notes, the variety is one that has a long seeding period and *it can be planted as late as the middle of February and still make a good crop.* As originally introduced it carried two types of heads and two types of kernels. One type possessed a white chaff, and the other a reddish brown chaff. The one type of kernel was light amber in color, and the other a reddish amber. Both of these types are still to be found in the commercial plantings of the last few years. *There is practically no Chul of a single pure type upon the market.* The Station has now separated the two types, and will send out no more of the mixed types. *Farmers who desire to secure a pure type of Chul are invited to correspond with the Station to that end.* In its ability to withstand drought it is a strong rival of the durum wheats. For instance, on one of the experiment stations of the University of California in 1908 it yielded at the rate of 63.3 bushels per acre and received less than eight inches of rainfall and was not irrigated. On another station the yield was at the rate of 63½ bushels per acre, with only ten inches of rain, and on still another station, at the rate of 51 bushels per acre.

Yields.—Chul wheat has made an exceptionally good showing in the field tests both on the Stations and in the field trials of farmers.

It has been tried, not only by the University of California, but also on a large scale by a considerable number of farmers in the vicinity of Williams, Arbuckle, and Maxwell during the past three seasons, under rather adverse conditions, and has given uniformly good results, although it had no rain after March 1st. In that section some 3000 acres of this wheat was grown in 1909, and a still larger acreage the past season.

REPORTS FROM FARMERS, 1910 CROP.

Through the medium of the University 161,082 pounds of this seed were distributed in 1909-10, and the reports upon the crop, so far as received, have been uniformly favorable and a much larger quantity was sold by growers directly.

Some of the growers report as follows:

No. 1; Woodland: Yield 12 sacks per acre. Will seed again this fall. "I think it is a very fine wheat. The north wind shrunk all grains except Chul."

No. 2; Dixon: Seeded in February. Yield 10 to 11 sacks per acre.

No. 3; Crows Landing: Seeded early in January. Received only 1½ inches of rain after seeding. Yield 16 sacks per acre. White wheat under same conditions made 12 sacks per acre.

No. 4: Seeded December 23. Yield 12 sacks per acre. Not so much pinched as other varieties.

No. 5; Newman: Seeded last of February. Yield 12.8 sacks per acre. Club seeded 15 days earlier gave 7 sacks.

No. 6; Waterford: Seeded last of December. Yield 8½ sacks per acre. Golden Gate Club under same conditions gave 5½ sacks per acre.

No. 7; San Miguel: Seeded December 15th. Yield 31.6 bushels per acre. Propo yield, under same conditions, 26.6 busnels per acre.

No. 8; Modesto: Average yield 13 sacks per acre on land considered worn out for wheat. "Even at high price paid for seed it has proven to be the cheapest I ever put in the ground."

No. 9; Collinsville: Grew 28 sacks from 300 pounds. Did not have a fair chance.

No. 10; Lynch: Yield 20 sacks per acre. White Australian under same conditions gave 14.3 sacks. Seeded December 20th.

No. 11; Orland: Yield 4 sacks per acre. White wheats about the same. Hot north winds seriously affected both crops.

No. 12; Walnut Creek: Seeded December 1st. Yield 15 sacks per acre. Other wheats on somewhat poorer land gave three sacks.

No. 13; Newman: Seeded December 1st. Yield 8 sacks per acre on rather poor land.

No. 14; Modesto: Yield 10 sacks per acre. White Australian 8 sacks.

No. 15; Hames: Propo and Chul both burned out by drought.

No. 16; Parkfield: Seeded December 2d. Yield 18.5 sacks per acre. White Australian seeded same day 15 sacks.

No. 17; Estrella: Seeded latter part of January. Yield 8 sacks per acre. "Seeded under very unfavorable conditions: ground too wet at the time of seeding and the weather was very unfavorable after that."

No. 18; Le Grand: Yield 11.7 sacks per acre. White Australian seeded about the same time yielded between 7 and 8 sacks. Seeded first part of January.

No. 19; Aptos: Yield 18 bushels on little less than an acre. Seeded about November 15th.

No. 20; Sacramento: Yield 13½ sacks per acre. The Chul came up stronger and was more vigorous all through the growing season than Club wheat sown under the same conditions alongside of it. Seeded about November 1st.

No. 21; Oakdale: "In a general way, will say that the Chul wheat has turned out better than Australian in this section. We are somewhat disappointed in some of the gluten tests. The wheat shows a great variation, some of it is very strong and some very weak."

No. 22; Hanford: Average yield 10 to 11 sacks per acre. Sonora wheat sown at the same time and under similar conditions yielded from 5 to 7 sacks.

No. 23; Concord: Yield 16 sacks per acre. "This I consider very good, as most wheat in this locality yields from 5 to 10 sacks per acre. Taking it all around, if the wheat produces like this every year it has no comparison with other wheats." Drilled on November 16th.

No. 24; Belmont: "Practically no yield of wheat. In March the field looked like a flower garden. Did not attempt to grow other grain."

No. 25; Lincoln: Yield 10.7 sacks per acre. Other wheat yielded 8.56 sacks per acre. Seeded October 20th.

No. 26; McArthur: "The Chul wheat gave promise of a good crop, but grasshoppers completely cleaned it up."

No. 27; Rio Vista: Yield 7 sacks. No other wheat under same conditions. Seeded January 10th.

No. 28; Santa Ana: "While the returns (from Chul wheat) are very small, I am very much gratified with the result as compared with the performance of Sonora wheat which was planted under like conditions and at the same time."

No. 29; Los Angeles: Yield about 15 sacks per acre. Seeded latter part of January. Fretes wheat under the same conditions yielded about 10½ sacks per acre and did not stand the dry weather as well as Chul.

No. 30; Cohn Ranch, Red Bluff: "Yield about 11 sacks per acre. It is hard to thresh out and for this reason is a good grain for the Sacramento Valley. Sowed the latter part of February, and had very little rain thereafter. White Australian alongside yielded 8.5 sacks to the acre."

The Milling Quality.—While the average gluten (protein) content of Chul is about 1 per cent. higher than the wheats commonly grown in California, as shown by the following, yet the millers offer some objection to it because of its hardness and the fact that the volume of loaf obtained from the flour is slightly less than some other wheats. But to offset this, its yield of flour is somewhat greater and the absorptive capacity of the flour is higher.

The slightly less volume of loaf is probably due to the quality of the gluten rather than to the smaller quantity. Still flour made from Chul wheat will produce a very fair loaf of bread of excellent texture and exceptionally good flavor. That this is true has been demonstrated by numerous bakings made in our own laboratories, and by loaves baked for us by a commercial baker in Oakland. The following illustration shows the relative size, appearance, and texture of a loaf made from a straight Chul flour and a baker's blend flour made from a California wheat flour and an Eastern flour from which the trade is regularly supplied with bread.

Fig. 27.—Showing relative size and texture of loaves baked from a regular baker's blend flour, and a straight flour from Chul wheat.

TABLE XVII.—COMPARISON OF NITROGENOUS INGREDIENTS OF CHUL WHEAT AND OF THE COMMON CALIFORNIA WHEATS.

	Analyses No. of	In dry matter		
		Nitrogen	Protein	Gliadin
(1) White Australian	42			
Average		1.74	9.89	3.74
Maximum		2.36	13.42	6.74
Minimum		1.22	6.92	1.86
(2) Washington Bluestem	33			
Average		1.80	10.18	3.83
Maximum		2.53	14.40	6.30
Minimum		1.25	7.15	1.98
(3) Sonora	17			
Average		1.71	9.71	3.48
Maximum		2.78	15.80	7.53
Minimum		1.34	7.59	2.26
(4) Propo	5			
Average		1.88	10.64	4.44
Maximum		1.92	11.94	5.39
Minimum		1.58	8.97	3.31
(5) Little Club	52			
Average		1.65	9.35	3.43
Maximum		2.40	13.64	6.24
Minimum		1.29	7.38	2.43
(6) Chul	55			
Average		1.91	10.84	3.35
Maximum		2.52	14.32	6.20
Minimum		1.36	6.73	1.46

The milling character of Chul will differ with individual lots according to its condition of culture, mainly time of seeding and the time at which it receives moisture. This is true of all varieties of wheat, and Chul is no exception in this case. Each lot should be judged upon its own merits as should all other wheats.

The wheat is considerably harder than the other types of wheat now handled by the millers, and the most economical method of handling the variety will have to be learned by further experience.

PROTEIN CONTENT OF WHEAT AS AFFECTED BY THE TIME OF OF SEEDING.

A large number of analyses of many varieties of wheat seeded both early and late have been made at the University laboratories and almost without exception it has been found that late planted wheat, while giving a smaller yield, produces a higher protein content. The

details of this work will be presented in a later publication. We present here, however, a contrast of early and late seeding of Chul and Fretes varieties grown on the California Station grounds as shown in Bulletin No. 178 of the United States Department of Agriculture.

TABLE XVIII—EFFECT OF THE LENGTH OF GROWING AND FRUITING PERIODS ON THE PROTEIN CONTENT OF THE CHUL AND FRETES WHEAT VARIETIES.

Grain Investigations No.	Variety	Length of Growing Period	Length of Fruiting Period	Protein*	Yield to the acre
2227	Chul	171	46	11.06	53.33
2227	do	151	41	12.43	52.89
1596	Fretes	177	45	10.94	56.00
1596	do	152	40	14.08	45.53

*The percentages of protein were obtained by multiplying the percentage of nitrogen by 5.7.

FRETES WHEAT.

Origin and History.[1]—Seed of Fretes wheat was received by the Office of Seed and Plant Introduction of the United States Department of Agriculture on September 26, 1901, from El-Outaya, Constantine, Algeria. It was obtained by Messrs. D. G. Fairchild and C. S. Scofield, who make the following notes on it:

"This variety, sometimes called Freitiss, is one of the few soft wheats grown in Algeria. It is particularly noted for its early maturity and is often extensively planted in the Sahara Desert in seasons when the winter rains occur so late that the durum varieties usually grown would not have time to mature. When planted in November, as it is in Algeria, at the same time with durum varieties, it is said to ripen two months in advance of them. The seed obtained was grown upon the rather salty desert sands in the vicinity of El-Outaya, north of Biskra, and watered with somewhat alkaline but still drinkable irrigation water. The variety is said to have originated from a shipment of Russian wheat which was made into Algeria at the time of a famine many years ago. Its early-maturing qualities attracted attention, and it has been cultivated in small quantities by the Arabs ever since."

Fretes wheat was first obtained by the Station in 1902 from the Seed and Plant Introduction Office and at once distributed to a few farmers in California, and good reports of its performance were received. It was placed in variety tests in the Station Experimental

[1] Bulletin 66, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1905. p. 151.

grounds in Sutter and Stanislaus counties in 1904-05, and has been grown on the testing stations ever since.

Description.—Fretes wheat is a free-stooling, prolific, semi-erect, vigorous, early, bearded wheat that should be seeded not later than January. It grows to a height of 3 to 4½ feet and stools fairly freely. The chaff does not inclose the grain as closely as that of the Chul, but compares well with White Australian in this respect. The kernels are of medium size and length, plump, and of a reddish color. They are much softer than those of Chul wheat.

Yields.—The observations made as to its adaptability to California conditions indicate that it is a heavier yielding variety than White Australian and is of fair milling quality.

The average yield of Fretes wheat as compared with White Australian under the same conditions on the University Stations is as follows:

	Stanislaus County	Yolo County
Fretes	46.5	42.7
White Australian	35.9	40.7

It has not been grown to any extent in acreage by farmers.

Milling Test.—A mill test of this wheat was made by the Oakdale Milling Company, Oakdale, California, which indicated that this variety was of a free milling character, and that the flour from the sample milled possessed a 40 per cent. wet gluten content against 38 per cent. for the White Australian milled at the same time and grown under the same conditions.

Fig. 28.—Fretes wheat, full size.

A BRIEF STATEMENT OF THE ESSENTIALS FOR SUCCESS IN GRAIN CULTURE.

1.—The minimum limit of precipitation for successful culture is about eight inches.

2.—When the precipitation is less than fifteen inches bi-ennial cropping, summer-fallowing, should be practiced.

It saves as much as possible of two seasons' rain for one crop.

It kills weeds which use up moisture, plant food, and increases the cost of operation.

It increases aeration, and makes plant food more available.

But it is destructive of humus, which must be restored by green-manuring.

3.—Add organic matter to the soil by turning under winter-grown rye, field peas or some other leguminous crop.

This improves the mechanical condition of the soil.

It enables it to hold more moisture.

It helps to make plant food more available.

It lessens washing, drifting and blowing of soils.

4.—For fall preparation of grain land plow not less than eight inches deep.

This enables rain to get into the soil easily.

It prevents run-off in case fo very heavy rain.

It provides more feeding space for plant roots.

It encourages deep rooting of plants.

It makes more plant food available.

5.—On light land sub-pack the soil immediately after plowing, using either a sub-packer or a disc-harrow.

This fills up air spaces in the furrow.

It gives a compact lower soil which brings moisture up to the plant roots.

It leaves the surface soil loose; the lower soil compact.

The press-wheels firm the soil about the seed, and hasten germination.

6.—Harrow to a good mulch or seed-bed immediately following the packer.

This prevents rapid evaporation of moisture, and provides a good seed-bed for quick germination.

7.—Seed with a drill with press-wheel attachment.

It distributes the seed evenly over the land.

It places the seed all beneath the surface of the soil at a uniform depth.

It requires less seed.

8.—Select large, vigorous, plump kernels of grain.

These have greater vitality and a greater reserve supply of plant food, thus producing more vigorous plants.

9.—Harrow the grain after it is well up.

This serves to retain moisture.

10.—Disc the land as soon as possible after the crop is off.

This tends to save residual moisture and gives a fine earth to turn under in the first plowing.

11.—In case of summer-fallow practice maintain a clean, well-cultivated soil mulch during the summer.

These all make for success in dry land farming.

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BERKELEY, CALIFORNIA

CALIFORNIA WHITE WHEATS

BY

G. W. SHAW and A. J. GAUMNITZ

BULLETIN No. 212

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1911

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CALIFORNIA WHITE WHEATS.

KINDS OF WHEAT.

NOTE.—The major part of this bulletin is the result of work done by Mr. A. J. Gaumnitz as a candidate for the degree of M.S. To the data so secured has been added other data which seemed to be closely related. Credit should particularly be given to Messrs. B. R. Jacobs, and E. J. Lea, for portions of the routine chemical work, and to Miss Edith Miller for the microscopic measurements.

At present agriculturists quite generally recognize eight species of the genus *Triticum*, as follows: *Triticum vulgare, Triticum compactum, Triticum turgidum, Triticum durum, Triticum polonicum, Triticum spelta, Triticum dicoccum,* and *Triticum monococcum.* The last three species named are of little value in this country directly, and become important only in so far as they are used in improving the commonly produced varieties by methods of breeding. Emmer and speltz are grown in considerable quantities in Russia, Germany, France, Spain, Italy and Servia, and the monococcum (einkorn or engrain) in the same countries, but to a lesser extent. Speltz is used mainly as cattle food. Emmer and monococcum are used as a human food to a limited extent.

Though the botanic characteristics of the Poulard, Polish and Durum types are quite distinct in kernels and other parts, their adaptation and uses are very similar. They are quite rank, hardy growers, and suited to the semi-arid regions. The Durums are well adapted for the production of macaroni.

Durum flour when blended with that of the common bread wheats, produces a bread which compares not at all unfavorably with that from ordinary flours. These wheats possibly may be used for blending to improve the common wheats, and especially California white wheats, for they are relatively high in gluten. From a field standpoint they are fairly rust resistant, are able to subsist on a minimum of moisture and at the same time withstand quite high temperatures.

The common bread wheats (*Tr. vulgare*) are a quite variable species and are the most extensively grown of any in the United States. They have been known especially for their bread-flour producing qualities, but setting aside prejudice it is questionable whether they should longer hold that title to the exclusion of the best durum varieties. There is a considerable difference in the bread-making qualities of the different varieties of the common wheats, and when the durum wheats of good

quality are ground into flour and baked, in comparison with the bread wheats, it is readily seen that in flour-yielding power, color and lightness of the loaf produced, they compare very favorably.

The hard wheat area is being rapidly extended northward into Alberta and adjacent provinces. This class of wheat is what the Minneapolis mills grind into their world-famed flours. Although some Kan-

Bearded type of common wheat. Beardless type of common wheat. A Durum wheat.

FIG. 1.—Showing typical wheat heads. One half natural size.

sas hard wheat is also used, they depend largely upon the northern hard wheat for the quality of their flour.

In contradistinction to the hard wheats, we may note the white (or soft) wheats of the central and Pacific coast region. These wheats are also spoken of as bread wheats, but they differ as widely from the hard winter wheats grown in the north central states as do the durum

wheats, so that for technical study at least they deserve separation and distinction.

These wheats, as indicated by the name, are very light colored as compared with eastern wheats; and further, they produce a very white flour. Some of these flours are nearly dead white, having practically no color value at all. Some samples have so little yellow that the lightest tinted yellow glass of the Lovibond tintometer is too yellow to match the flour. The Sonora variety, however, yields flour that has even more of the yellow color than the average eastern flour.

FIG. 2.—Showing types of common bread wheats. One half natural size.

The wheats most widely grown in California are Little Club (commonly called Salt Lake Club), White Australian, Washington Bluestem, Sonora, and Propo.* There are a few other varieties scattered here and there in the State, but the above-named varieties are the only ones which can be said to have a wide favor with farmers in the large wheat-growing areas at the present time. Those of lesser importance are Golden Gate Club, Defiance, and White Chili.

*NOTE.—This wheat is sometimes called "Proper" instead of Propo.

At this date it is impossible to obtain any very accurate information as to when these wheats were introduced into the State, but doubtless most of them came from Australia. This is certainly true of White Australian and probably of Sonora, although the latter may have come by the way of Mexico. Of the former, Mr. G. W. McNear writes that it was imported from South Australia in the early sixties. It is even now grown there under the name of White Lammas.

Sonora is also grown extensively in Australia under the name "Velvet Pearl." Washington Bluestem is a strain very closely related to White Australian, and is probably an Australian importation corresponding to the variety now grown there under the name of Purple Straw. White Chili was imported in the early fifties, and if not the same, is very closely allied to Oregon Big Club. Of Propo, Mr. R. M. Shackleford, of Paso Robles, for many years connected with the milling trade of this State, is authority for the statement that this variety was a field selection from a sowing made from a shipment of wheat from Chili; the selection being sufficient in quantity to seed thirty acres of land in the Panoche Valley. From this thirty acres there was produced about five hundred sacks of wheat. Mr. Shackleford writes:

"I purchased this wheat and shipped it to Mr. A. D. Starr, of Marysville. The name given to this wheat at the time I purchased it was 'Snowflake,' and I shipped it to him under that name. There was some little seed left in the country, and quite an inquiry arose for the same seed. Mr. Starr returned me two car loads—one in the Salinas Valley, and one to Hollister. He reported to me the proper name was Propo. My memory is that was the name that was given to it at the time I purchased it, but old settlers tell me it was called 'Snowflake,' and that until it was returned from the north it was not known as 'Propo.' This leads me to believe that some of the original seed was distributed in the north and raised much as it was in San Benito County, and that it received the name Propo or Proper from the party who there grew it. My opinion is that this is a complete history of the introduction of Propo wheat into California."

The wheat was at one time held in high esteem both by farmers and millers. The latter still regard it highly as compared with the other California varieties, but growers have gradually drifted to one or another of those mentioned previously as giving greater returns in yield in the interior valleys. In the coast sections, however, Propo still holds its own and constitutes the bulk of the wheat there produced.

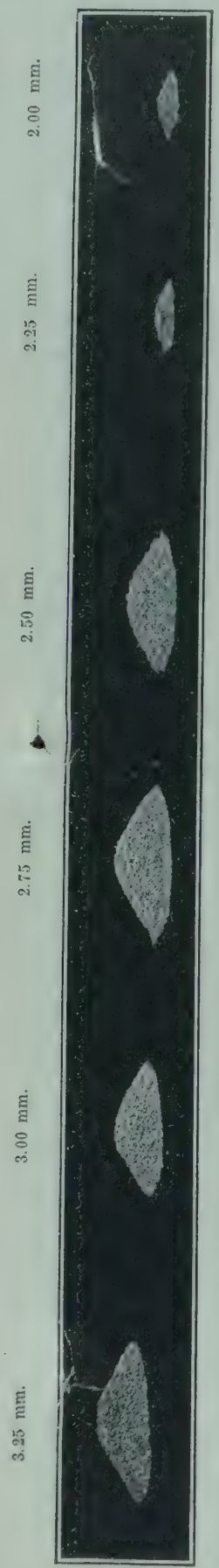


FIG. 4.—Showing relative per cent of various sizes in a typical White Australian wheat. The figures at the top indicate the size of mesh in millimeters of the screen used to separate each lot; the figures at the bottom express the percentage of the whole in each pile.

FIELD CHARACTERISTICS.

WHITE AUSTRALIAN.

This is a free-stooling, prolific, hardy, late, mid-season wheat. It is quite subject to rust attacks, and has only a medium tenacity. It is not well adapted to the coast sections on account of its liability to rust.

FIG. 3.—White Australian wheat.

CHARACTERISTICS OF GROWTH.

Stools: Fairly abundant, spreading, rather creeping.

Straw: White, strong, supple, rather tall.

Foliage: Good color, abundant, drooping, slightly glaucous.

Heads: Bald, smooth, long, regular, somewhat open, rather slender, tapering.

Spikelets: Narrow, two to three grained, not close.

Grain: Large, long, plump, white, soft, opaque, starchy interior. The grain is of pleasing appearance and generally of good bushel weight.

A typical White Australian should grade about as follows (Fig. 4):

FIG. 6.—Showing relative per cent of grains of various sizes in a sample of typical Little Club wheat. The figures at the top indicate the size of mesh in millimeters of the screen used to separate each lot; the figures at the bottom express the percentage of the whole in each pile.

LITTLE (SALT LAKE) CLUB.

FIG. 5.—Little Club. One half size.

This is a strong-growing, medium-stooling, hardy, mid-season wheat. It is very subject to rust attack. The chaff has a very high tenacity, this being one of the particular points in its favor in the interior valleys where the winds are strong. It ripens a little earlier than White Australian and is somewhat more prolific.

CHARACTERISTICS OF GROWTH.

Stools: Few and erect, strong-growing.

Straw: White, strong and of medium height.

Foliage: Good color, fairly abundant, upright and smooth.

Heads: Awnless, smooth, short, flat, compact; chaff yellow and tenacity high.

Spikelets: Wide, 2-5 grained, close.

Grain: Medium large, short, white, irregular in shape, very soft and starchy interior. The grain has a flat side which makes it apparently larger than is really the case.

A good type of the Little Club should have about the following grade (Fig. 6) based upon the method of grading by sieves as set forth in Bulletin 181 of this station.

SONORA.

FIG. 7.—Sonora wheat. One half size.

This is a light-stooling, rapid-growing, early wheat. It is much subject to rust, hence only adapted to the interior valleys. Its leaves are narrow and thin, and well adapted to withstand considerable drought. For this reason it has been the variety which has held its own in those portions of the State most subject to drought, namely in the southern portion of the San Joaquin Valley.

CHARACTERISTICS OF GROWTH.

Stools: Few and erect with medium growth.

Foliage: Light color, not abundant, texture thin, surface rough.

Heads: Long, medium thick, somewhat flat, compact, hairy and awnless.

Spikelets: Three-grained.

Grain: Short, round, plump, white, starchy interior. It is of unusually pleasing appearance and of good bushel weight.

The grading of a good sample of Sonora showed as follows (Fig. 8):

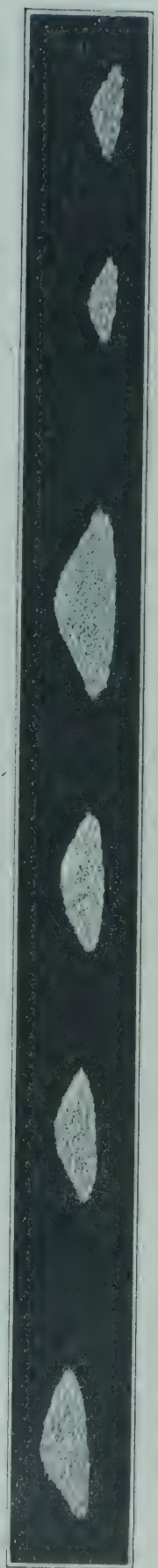


FIG. 8.—Showing relative per cent of various sizes of kernels in a typical Sonora wheat. The figures at the top indicate the size of mesh in millimeters of the screen used to separate each lot; the figures at the bottom express the percentage of the whole in each pile.

FIG. 9.—Propo wheat. One half size.

PROPO.

This is a fair-stooling, medium early, vigorous growing, bearded variety. Its yielding capacity is unusually good where winds are not too severe. The texture of the leaf is rather thin, thus enabling it to withstand rather severe drought.

CHARACTERISTICS OF GROWTH.

Stools: Fairly abundant, slightly spreading.

Straw: Purplish white, medium strong, good height.

Foliage: Dark green, drooping, only fairly abundant, slightly rough.

Heads: Bearded, smooth, long, open, medium slender, tapering.

Spikelets: Medium wide, open, three grained.

The relative percentage distribution of these several sorts of wheat in the State is shown in the following table, taking the points named as centers, the figures given being the results of estimates of a large number of buyers in the several regions.

TABLE I.—SHOWING COMPARATIVE DISTRIBUTION OF VARIETIES OF WHITE WHEAT IN CALIFORNIA.

Tributary to	Little Club	White Australian	Bluestem	Chili	Sonora	Propo
Visalia	5	30	0	0	60	5
Fresno	0	30	10	5	50	5
Madera	5	70	10	10	2	3
Modesto	0	60	40	0	0	0
Stockton	30	50	15	5	0	0
Sacramento	50	20	10	10	10	0
Woodland	90	0	10	0	0	0
Marysville	20	30	20	30	0	0
Chico	85	5	10	0	0	0
Salinas	0	15	0	0	0	85
Paso Robles	0	50	0	0	10	40

These estimates show that the Little Club is the favorite variety in the northern portion of the Sacramento Valley, that it declines rapidly in popularity as one goes southward and can hardly be called popular south of the country tributary to Stockton. In the coast section it is not grown at all. White Australian seems to have a more widely distributed popularity than any of the other sorts. It has its widest use in the middle San Joaquin section and the uplands of the coast region.

Washington Bluestem has come into wide favor during the last few years in the middle San Joaquin section and its use is extending northward in the Sacramento section. This wheat has all the characteristics of the White Australian, and it is very questionable as to its being at all different.

White Chili can be said to be popular only in the section about Marysville, although it has a scattered use extending even as far south as Fresno.

Sonora is in wide use only in the southern portion of the San Joaquin Valley, where its marked drought-resistant qualities have doubtless made it a "survival of the fittest."

Propo, although widely grown some twenty-five years ago in the Sacramento Valley, has been superseded entirely by other wheat. It is grown to a considerable extent now only in the coast section, especially about Paso Robles. This wheat was, and still is, held in high esteem by the milling trade.

FIG. 10. White Chili. One half size.

IMPURITIES.

Before conducting the following tests the samples selected were subjected to cleaning for the removal of the weed seeds present. The nature of foreign seeds found during this work is shown in the following table:

TABLE II.—SHOWING WEEDS FOUND

Number of Sample.	44.	62.	67.	73.	80.	81.	204.
1. *Agrostemma githago.* Corn cockle							
2. *Amsinckia intermedia.* Burweed, fire-weed					3	50	
3. *Anthemis cotula.* Mayweed, dog-fennel							10
4. *Avena fatua.* Wild oats							1
5. *Avena sativa.* Cultivated oats	59	1	22	12	22		
6. *Bromus maximus.* Broncho grass							
7. *Centaurea.* Star thistle (small flower)							
8. *Convolvulus.* Bindweed, morning-glory							
9. *Gilia* (tiny seeds)							
10. *Gnaphalium.* Cudweed, everlasting (infinitesimal seed)							
11. *Hemizonia.* Tarweed						9	
12. *Hordeum vulgare.* Cultivated barley	33	17	256	204	2	6	10
13. *Leptocaulis* (parsley family)							
14. *Lolium perenne.* Rye grass		1					
15. *Lolium temulentum.* Poison darnel; poison rye grass	15		3	25	48		17
17. *Phalaris paradoxa.* Gnawed canary grass							
18. *Medicago denticulator.* Burr clover							2
19. *Raphanus sativus.* Wild radish							
20. *Heliotropium currassavicum.* Wild heliotrope			20				
21. *Rumex crispus.* Curly dock							
22. Vetch							1
23. Smut wheat	3	20	15	12	8	20	
24. Number of foreign seeds	107	19	301	241	75	65	40
25. Percentage of impurities (foreign seeds)	3.7	9	23	13	2.6	2.2	7.5

The table is of interest particularly in showing, not only the extreme more especially because *all of these wheats were actually being used by* being the case, there is abundant reason for the extreme weediness of the of the combined harvester to scatter weed seeds in the fields.

IN SEED WHEAT SAMPLES.

206.	208.	211.	229.	255.	276.	279.	284.	289.	296.	300.	306.	314.	320.	325.	208.
	1														2
	7	3										36	8		
		72								66		120			150
1	1	13	8	66	1	5	13	17	3	2				1	
	1										6	14			1
	1	34													2
1						2									
													21		
												50			
											5	2	80		2
5		14	3	17			1	4	2		6			1	1
															13
	34														30
3	80	121	6	17	508	56	6	18	11		4				122
					6	3									
		10													
					2										
															1
						3									1
	1		1					14	2				4	6	2
11	125	257	16	100	517	69	20	39	16	70	21	222	109	2	323
3.1	26.2	31.0	2.7	5.8	36.7	6.2	2.7	5.3	2.0	17.7	1.3	14.0	10.4	.15	29.4

weediness of the field on which most of these wheats were grown, but *farmers for seeding purposes in the condition here represented.* This fields in the wheat-growing areas of the State, aside from the tendency

PHYSICAL CHARACTERISTICS OF WHEAT.

The physical character of wheat has been the basis of much study, and certain chemical properties have been shown to be closely associated with well-defined physical characters. The milling qualities of wheats have also been found to be more or less closely associated with certain physical features, especially size of grain, hardness, thickness of bran, and bushel weight.

In Bulletin 181 of this station is discussed in detail the matter of size of kernel of a large number of samples of seed wheat collected from farmers.

The relative size of kernels of different kinds of wheat is determined by the use of a series of sieves, by weighing a definite and considerable number, or, what amounts to the same thing, counting the number in a certain weight, or by taking the weight per bushel. No one method can be relied upon altogether, because of the variation in the specific gravity; difference in maturity, causing the grain to be misshapen; and difference in normal shape of the kernels. In a general way, these differences are equalized and eliminated, by taking well-matured grain and depending not upon individual determination but upon several determinations and averages from these.

There is no recognized standard to represent the different sizes of grain, but after considerable study of the range of variation in the grains of wheat, the following meshes have been adopted as suited to the conditions of this study:

Size.	1	2	3	4	5	6
Mesh diam.	3.25 mm.	3.00 mm.	2.75 mm.	2.50 mm.	2.25 mm.	2.00 mm.

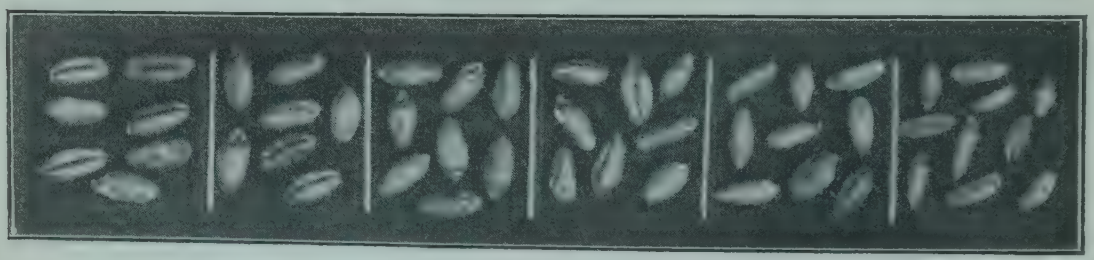


FIG. 11.—Showing actual size of grain separated by each sieve.

The common method of the grading of wheat is by separation of the grains according to size. This is most conveniently done by means of sieves. The grains in a given sample vary in size. If the sample be passed through a sieve having a mesh sufficiently large to retain only the very largest grains, and then successively through sieves with smaller and smaller meshes, until no more grains will pass through, the sample will have been *graded,* that is, each lot or pile of wheat will consist of grains of a definite size.

The character of the mesh has much to do with a proper grading by this method. The shape of the wheat-grain is such that a slit is required for the openings in the sieves in order to allow the passage of the grain. An examination of the wheat-grains will show that the two transverse diameters are not of the same size, and this must be regarded as having reference to the shortest diameter in each case. This difference in transverse diameter of grain is easily observed in Fig. 11.

The separations were in each case made upon samples consisting of plump grains. The grain represents the crops of three consecutive years extending from 1904 to 1906 inclusive.

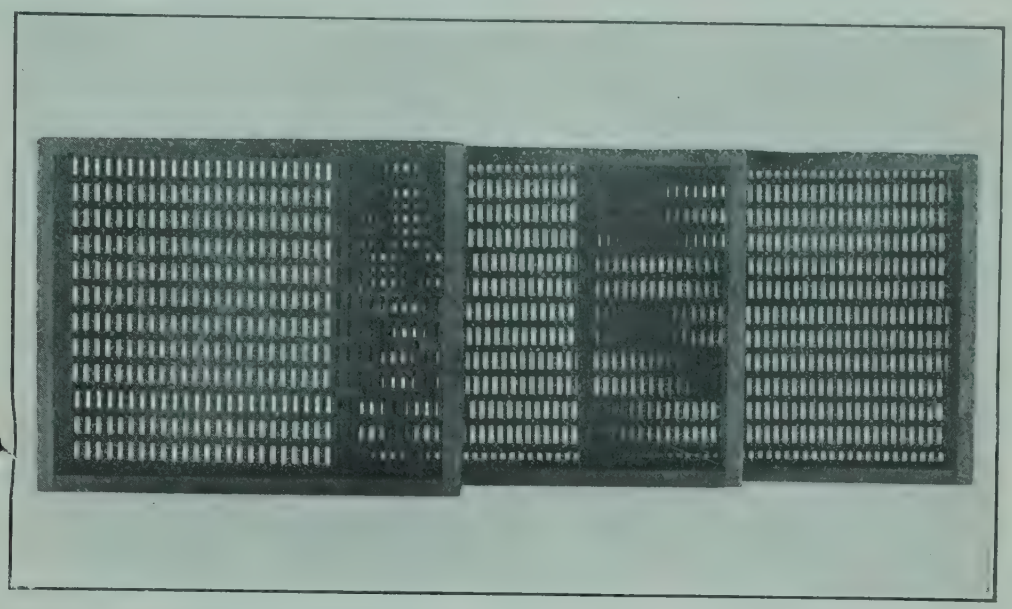


FIG. 12.—Showing the style of sieve used in the separation of the different sizes of kernels.

The several types enumerated above, when separated by means of the sieves here described, gave the following results:

TABLE III.—SHOWING MEAN RELATIVE SIZE OF GRAINS OF COMMON CALIFORNIA WHEAT.

	No. of sample.	Size 1. 3.25 mm.	Size 2. 3.00 mm.	Size 3. 2.75 mm.	Size 4. 2.50 mm.	Size 5. 2.25 mm.	Size 6. 2.00 mm.
White Australian	43	11.62	10.51	24.71	44.69	7.01	1.64
Bluestem	32	12.84	11.63	25.32	40.56	7.17	2.40
Little Club	55	14.52	7.47	17.13	47.88	10.25	2.72
Sonora	11	1.84	2.53	14.08	57.10	20.80	3.69
Propo	7	8.56	9.05	17.68	53.60	9.96	1.19

The above table of grading shows certain characteristics of the grain which will also be observed upon studying the appearance of the grains from the different varieties as shown in the illustrations. In the first place the similarity of the grading of White Australian and Bluestem will be noted, which is in line with the statement made in an earlier paragraph, that these two varieties were very closely related, if they are not even the same variety passing under different names. White Australian carries 46.8 per cent. of its grains in the first three sizes while

49.7 of the grains of the Bluestem are carried in the same sizes, and further it will be noted that the distribution in the three sizes is also essentially the same. The Little Club variety is distinctly different from these types and also from those following, the grading giving one the idea that it is a small grain, whereas the appearance to the eye gives one the impression of a relatively large grain. This is doubtless due to the peculiar shape of the Club grain. It has one flat side which makes its transverse diameter really smaller than is apparent. Both the Propo and the Sonora appear from the grading to be small grains. This is actually true of the Sonora, but of the Propo this is only true of its transverse diameter, the grain being rather longer than that of the White Australian.

A circumstance shown by this table is the larger weights in per cent. retained on the 3.25 mm. than on the 3 mm. sieve in the first three cases. One would expect to find the relations which are shown by the Sonora and Propo. In an examination of individual determinations a considerable difference is found in favor of the 3.25 mm. sieve. The largest being 24.2 per cent. on the larger sieve to 11.8 per cent. on the next lower size, while below this the percentage increases to the maximum on the 2.5 mm. sieve.

RELATION OF SIZE OF KERNEL TO FLOUR YIELD.

This matter of size of grain has an important bearing upon the milling value of a wheat, especially as between samples of the same variety, other things being equal. For instance, of two wheats otherwise of equal value for milling, the one whose grains are the larger will give the larger yield of flour. Millers pretty generally recognize this by screening out the smallest grains. This may also be shown by certain results obtained with the mill at this laboratory. Further, we might expect this *a priori*, because there is bound to be larger percentage of bran upon the smaller grains of the same variety.

The following table is intended to show this fact. Here is shown the average grading of a number of samples of grain, each of which has been milled so as to secure the total yield of flour after the same style of milling. For the sake of this comparison, the first three sizes are grouped together and the last three sizes together, and are arranged in order of relative size of grains, the total number of samples used (52) being separated into four groups of thirteen samples each for securing an average:

TABLE IV.—SHOWING THE RELATION OF SIZE OF GRAIN TO YIELD OF FLOUR.

No. of Samples Represented.	Sizes 1, 2, 3.	Sizes 4, 5, 6.	Total flour yield
13	5.3	94.7	69.1
13	15.9	84.1	69.7
13	28.9	71.0	70.7
13	60.7	39.3	71.4

PHYSICAL CHARACTERISTICS.

Table V shows certain physical characteristics of the grains. In it is shown the relative size of the kernels as measured by the number in 10 grams, the average weight per kernel, the bushel weight, the hardness when tested under uniform conditions, and the grade as determined by sieves as described heretofore.

In Table VI is given a summary of four types, the grouping being in accordance with the number of grains per 10 grams, and subdivided into groups having a range of 50 kernels each. In each case the number of samples falling in each group is given. This is significant in establishing the relation between the four types, as to the relative number of samples from each type falling in the same group, which allows comparisons to be made between the different kinds of wheat of the same size grain.

TABLE V.—SHOWING AVERAGE WEIGHT AND HARDNESS OF CALIFORNIA WHITE WHEATS.

Bluestem.

Laboratory number.	No. of kernels in 10 grams.	Average weight per kernel.	Weight per bushel.	Number of unbroken grains under weight of					Total number of unbroken grains.*
				.75 lbs.	1.00 lbs.	1.25 lbs.	1.50 lbs.	1.75 lbs.	
64	225	.0444	62.	100	100	96	82	59	437
606	231	.0432	61.	99	98	94	94	60	445
118	237	.0421	62.75	100	100	91	75	42	408
17	242	.0413	61.	100	72	48	17	0	237
24	242	.0413	59.50	93	68	41	20	0	222
25	243	.0411	61.	99	54	32	8	0	193
152	245	.0408	00.	94	84	64	40	5	287
9	257	.0389	61.12	100	83	48	0	0	231
303	263	.0380	61.	100	100	84	58	25	367
121	267	.0374	62.	100	95	81	53	13	342
268	268	.0373	60.25	100	88	54	16	2	260
472	271	.0369	59.	100	99	79	60	15	353
15a	277	.0361	00.	100	89	66	36	0	291
10a	277	.0361	58.50	87	71	56	30	3	247
16	279	.0358	60.12	100	43	28	0	0	171
15	280	.0357	61.25	100	54	17	0	0	171
4	285	.0350	57.	100	47	20	0	0	167
14	287	.0348	61.	100	87	31	0	0	218
371	292	.0342	59.50	99	74	37	12	0	222
299	298	.0335	59.50	94	91	65	24	11	285
267	309	.0323	59.75	95	74	37	12	6	224
206	313	.0319	60.50	95	77	54	0	0	226
205	313	.0319	60.75	72	63	51	19	7	212
300	314	.0315	56.25	99	91	68	18	0	276
5	314	.0315	60.25	100	43	22	0	0	165
386	334	.0299	58.75	99	77	43	12	0	231
272	350	.0285	59.50	100	86	63	50	22	321
Average	278	.0363	60.125	97	78	54	36	20	267

*NOTE.—The figures in this column represent the sum of the figures in the preceding five columns.

TABLE V (CONTINUED).—SHOWING AVERAGE WEIGHT AND RELATIVE HARDNESS OF CALIFORNIA WHITE WHEATS.

Australian.

Laboratory number.	No. of kernels in 10 grams.	Average weight per kernel.	Weight per bushel.	Number of unbroken grains under weight of					Total number of unbroken grains.
				.75 lbs.	1.00 lbs.	1.25 lbs.	1.50 lbs.	1.75 lbs.	
452	216	.0462	59.5	100	99	84	77	35	395
26	237	.0421	60.5	100	99	90	84	61	434
67	240	.0416	62.75	100	98	88	61	54	401
73	249	.0401	63.12	100	100	90	61	24	375
416	255	.0392	58.25	100	98	88	83	50	419
127	256	.0390	61.75	100	91	37	4	0	232
605	256	.0390	62.	100	100	100	90	53	443
129	259	.0386	60.50	100	83	50	7	0	240
68	260	.0384	62.25	100	100	90	56	16	362
66	261	.0383	61.25	100	100	93	75	28	396
23	264	.0378	62.25	61	39	11	0	0	111
62	267	.0374	62.75	100	81	47	20	0	248
453	268	.0373	60.50	100	97	85	81	47	410
311	268	.0373	61.	100	98	91	34	0	323
231	272	.0367	63.	100	90	88	60	43	381
304	274	.0364	62.50	100	96	88	34	9	327
134	280	.0357	62.	95	54	23	0	0	172
288	281	.0355	62.50	100	96	86	56	27	365
232	288	.0347	59.50	95	86	77	28	3	289
69	293	.0341	60.25	100	95	61	22	10	278
138	298	.0335	00.	92	50	23	0	0	165
184	298	0.335	60.50	97	80	22	0	0	199
322	299	.0334	60.50	100	100	93	31	0	324
28	300	.0333	60.25	100	99	85	46	25	355
275	302	.0331	59.	98	79	45	13	6	241
22	306	.0326	60.50	100	99	85	46	25	355
141	316	.0316	00.	95	50	26	0	0	171
326	326	.0306	61.	96	87	72	24	14	293
309	330	.0303	59.50	95	92	80	63	19	349
312	330	.0303	58.	100	99	92	22	12	325
78	337	.0296	52.50	100	92	42	6	0	240
77	342	.0292	60.	100	95	58	11	0	264
319	369	.0271	59.50	100	84	43	0	0	227
310	375	.0266	57.50	100	66	18	0	0	184
359	443	.0225	53.	99	45	29	18	4	195
Average	292	.0341	60.29	97	86	65	43	26	299

TABLE V (CONTINUED).—SHOWING AVERAGE WEIGHT AND HARDNESS OF CALIFORNIA WHITE WHEATS.

Little Club.

Laboratory number.	No. of kernels in 10 grams.	Average weight per kernel.	Weight per bushel.	Number of unbroken grains under weight of					Total number of unbroken grains.
				.75 lbs.	1.00 lbs.	1.25 lbs.	1.50 lbs.	1.75 lbs.	
96	210	.0476	59.50	100	100	100	100	100	500
459	226	.0442	59.	100	97	96	91	83	467
441	235	.0425	61.50	100	100	99	95	94	488
443	236	.0425	62.50	100	100	98	96	90	484
436	243	.0411	62.12	100	99	99	97	82	477
446	243	.0411	63.	100	99	97	95	87	478
440	244	.0409	60.	100	100	100	96	86	482
439	247	.0404	61.	98	94	94	91	33	410
607	248	.0404	63.	100	100	98	85	53	436
449	252	.0396	60.	100	99	94	90	62	445
445	255	.0392	60.75	100	100	100	90	70	460
448	263	.0380	62.	100	100	99	91	79	469
124	271	.0369	62.	98	81	55	10	0	244
438	274	.0364	60.	100	100	97	87	59	443
130	282	.0354	60.25	100	80	45	10	0	235
444	285	.0349	63.	100	95	89	86	77	447
28a	286	.0349	00.	94	83	52	13	0	242
442	289	.0346	62.	100	100	97	96	86	479
6	292	.0342	61.25	100	92	67	13	0	272
144	306	.0326	60.	99	66	21	0	0	186
372	311	.0321	60.75	100	100	97	86	44	427
139	314	.0315	00.	95	76	34	6	0	211
128	315	.0317	59.	100	84	36	7	0	227
51	316	.0316	58.50	47	21	9	0	0	77
51a	317	.0316	58.50	47	21	9	0	0	77
266	317	.0316	60.75	99	76	39	0	0	214
315	330	.0303	59.	97	70	12	2	0	181
161	330	.0303	62.	100	92	57	20	6	275
8	332	.0301	60.	100	63	39	0	0	202
27	334	.0299	58.25	98	92	72	71	7	340
53	336	.0297	61.	100	93	58	23	7	281
143	337	.0296	00.	98	68	30	2	0	198
11	340	.0294	59.	100	43	31	0	0	174
59	342	.0292	60.50	100	92	64	29	4	289
80	355	.0281	60.	100	96	64	30	3	293
57	356	.0279	60.25	99	85	54	25	5	268
21	360	.0277	59.	94	35	27	25	0	181
56	363	.0275	60.50	99	88	47	17	5	246
49	363	.0275	60.	54	46	14	8	0	112
50a	363	.0275	58.50	23	0	0	0	0	23
50	363	.0275	59.50	23	0	0	0	0	23
58	366	.0273	60.50	100	97	63	23	3	286
277	367	.0272	57.75	100	60	29	0	0	189
253	373	.0268	59.	99	79	40	8	0	226
60	377	.0265	63.	72	43	24	10	3	152
305	377	.0265	59.50	78	66	41	20	0	205
54	390	.0256	61.12	100	92	58	24	8	282
55	390	.0256	59.	96	82	41	13	0	232
317	419	.0238	59.25	95	37	18	0	0	150
290	537	.0186	58.87	100	77	48	25	0	250
Average	323	.0325	60.33	92	80	60	48	47	288

TABLE V (CONTINUED).—SHOWING AVERAGE WEIGHT AND HARDNESS OF CALIFORNIA WHITE WHEATS.

Sonora.

Laboratory number.	No. of kernels in 10 grams.	Average weight per kernel.	Weight per bushel.	Number of unbroken grains under weight of					Total number of unbroken grains.
				.75 lbs.	1.00 lbs.	1.25 lbs.	1.50 lbs.	1.75 lbs.	
167	254	.0393	61.50	98	92	71	35	7	303
481	272	.0367	66.	100	100	100	99	80	479
245	276	.0362	64.75	100	100	93	77	34	404
74	296	.0337	65.	100	97	87	55	25	364
76	337	.0296	63.	100	100	94	66	32	392
33	356	.0280	64.25	100	96	87	73	52	408
63	359	.0278	64.	100	93	75	26	9	303
249	371	.0269	64.75	96	91	75	75	33	370
140	444	.0225	61.	100	70	29	4	0	203
137	457	.0218	63.50	97	65	24	0	0	186
257	518	.0193	60.25	94	68	42	17	0	221
Average	358	.0292	63.45	98	88	70	52	34	330

Propo.

Laboratory number.	No. of kernels in 10 grams.	Average weight per kernel.	Weight per bushel.	Number of unbroken grains under weight of					Total number of unbroken grains.
				.75 lbs.	1.00 lbs.	1.25 lbs.	1.50 lbs.	1.75 lbs.	
46	236	.0423	61.	100	100	89	53	27	369
45	270	.0370	60.25	100	76	55	40	17	288
47	322	.0310	63.50	100	92	78	34	7	311
79	341	.0293	62.75	100	94	52	14	0	260
Average	292	.0349	61.87	100	90	69	35	17	307

TABLE VI.—SHOWING PHYSICAL CHARACTERISTICS OF WHEATS BY GROUPS.

Bluestem.

Range of seeds per 10 grams.	Number of samples in group	Average number of kernels in 10 grams	Weight per bushel, pounds	Number of kernels unbroken under weight of						Sieve grading.	
				.75 lbs.	1.00 lbs.	1.25 lbs.	1.50 lbs.	1.75 lbs.	Total	Sizes 1, 2, 3	Sizes 4, 5, 6
200-250	7	238	61.2	98	82	66	48	27	318	68.3	31.7
251-300	13	277	60.0	98	78	51	22	5	256	54.4	45.6
301-350	7	321	59.4	94	73	48	16	5	236	35.2	64.8
Average	27	274	60.2	96	78	55	29	12	270	52.6	47.4

Australian.

200-250	4	234	61.5	100	99	88	71	43	401	65.5	34.5
251-300	19	274	61.3	97	86	66	36	15	300	50.3	49.7
301-350	9	321	58.8	98	88	65	28	12	291	31.8	68.2
351-400	3	396	56.6	100	65	30	6	1	202	10.4	89.6
Average	35	306	59.5	99	85	62	35	18	299	39.7	60.3

Little Club.

200-250	9	237	61.3	100	99	98	94	79	470	72.6	27.4
251-300	10	275	61.3	99	93	80	59	43	374	60.1	39.9
301-350	15	325	59.8	92	72	41	15	4	224	30.8	69.0
351-400	14	359	59.8	81	72	41	14	2	210	15.0	85.0
Average	48	299	60.5	93	84	65	46	32	319	48.1	51.9

Sonora.

200-250	4	275	64.3	100	97	88	67	37	389	35.7	64.3
251-300	1	337	63.0	100	100	94	66	32	393	10.4	89.6
301-350	3	362	64.3	99	93	79	58	31	360	12.9	87.1
351-400	1	444	61.0	100	70	29	4	0	203	0.0	100.0
401-450	1	457	63.5	97	65	24	0	0	186	1.6	98.4
451-500	1	518	60.3	94	68	42	17	0	221	2.5	97.5
Average	8	323	63.8	100	97	87	64	33	380	19.6	80.4

Grand Average.

200-250	25	246	62.1	99.5	94.2	85.0	70.0	47	395	60.5	39.5
251-300	40	314	61.4	98.5	89.2	72.7	45.7	25	306	43.8	56.2
301-350	34	332	60.4	96.2	81.5	58.2	28.5	2	266	27.7	72.3
351-400	18	399	59.1	93.6	69.0	33.6	8.0	1	205	8.5	91.5

The discussion of the results appearing in the tables of physical characteristics will be based upon the small tables of averages (Table VI)

in order to eliminate the influence of a number of apparently extreme variations which do not seem to be entirely consistent. In the case of Sonora wheat the groups 350–400, 400–450, 450–500 are also eliminated in making up the averages, inasmuch as but a single sample appears in each of these groups, and the previous table shows such a range between different samples that it is thought unsafe to base any statement upon these groups carrying but a single sample.

Relative Size of Varieties.—In this table the relative size of the several varieties is shown in two ways, namely, the average number of grains in 10 grams and the sieve gradings, sizes 1, 2, 3, being the larger-sized grains. Considering the varietal averages as shown in the table, it will be seen that as to size of kernel the varieties stand in the following order in both instances: Bluestem, Little Club, Australian, Sonora. A constant relation is seen to exist between the size of grain as shown in sieve grading, and the weight per bushel.

The table shows in every instance that the weight per bushel increases as the number of grains per 10 grams decreases, that is, as the size of the kernel decreases, the weight per bushel decreases, provided the type of grain remains the same, but if the type changes and the size of grain remains the same the weight per bushel may vary widely. As, for instance, the bushel weight of Bluestem and Little Club in the 251–300 group, with an average number of kernels per 10 grams respectively of 277 and 275, the Bluestem weighed but 60 pounds per bushel, while the Little Club showed 61.3, or a difference of over 2 per cent. *It would appear, then, that in the use of this factor in the judging of grains it should be applied only to lots of the same variety.*

Hardness of Kernels.—It is generally held that the hardness of a grain gives, in a rough way, its general adaptability for milling purposes, particularly if the test be applied within the variety. This test is usually given in the purchase of grain by the biting of several kernels, but it is very doubtful if an approximate idea of the relative hardness of kernels of the same variety can thus be established. As between durum varieties and the white wheats it would, of course, be possible to differentiate, and also between the darker-colored wheats of the middle west and white wheats of the west, but as between one lot of Australian and another the matter is very doubtful. Further, it has certainly not been demonstrated that this is a factor of importance. Nevertheless, an attempt was made to make a comparison of these common California sorts, in the matter of hardness, by some method approximating as nearly as possible the biting method, by means of mechanical means of such a nature as to measure the weight used in each case to break the grain, and in this manner establish a means of comparison in this respect.

The apparatus employed consisted of a pair of ordinary pincers, as shown in the illustration, mounted upon a suitable standard, with a weight attached to the upper arm by means of a wire. A number of more complicated arrangements were tried, but none seemed to give more uniform results than this simple contrivance. The tests were made with five different weights—0.75, 1.00, 1.25, 1.50, 1.75 pounds, respectively. One hundred grains were counted out for each weight, and the hardness obtained by opening the jaws of the pincers just wide enough to insert the grain between them, and then allowing the weight to settle gently. The grains remaining unbroken by each weight were set aside and counted. The work was done under as nearly uniform conditions as possible. The authors are inclined to doubt the fact that the hardness of the grain bears any very definite relation to the milling value. If such were the case, one would expect to find the varieties under such a test as this arranging themselves in nearly the same

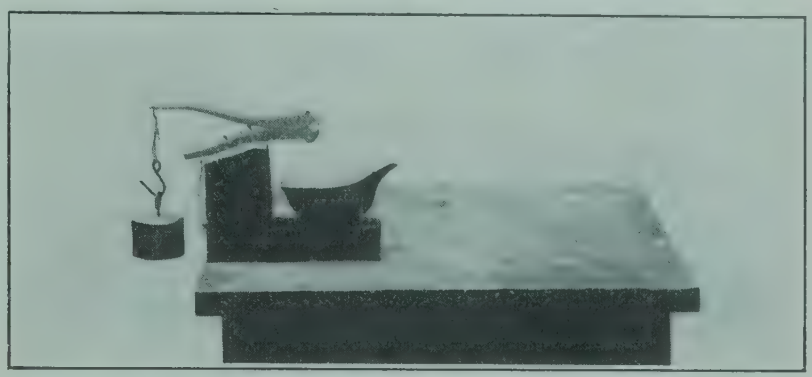


FIG. 13.—Showing apparatus used in testing hardness of kernels.

order as the results obtained on the mill, and this can not be said to have been the case in the case of individual samples, although it must be admitted that the general trend of results points in that direction.

The facts which are evident from this trial are as follows; within the varieties individually the larger the grain the harder, which it will be noted is in the same direction as the flour yield. This appears to be true in each one of the varieties tested, without exception. Again, the greater the weight per bushel within the variety the harder the kernel. This, of course, means that the more dense the kernel the greater is its weight per bushel, other things being equal. Thus, between two lots of wheat of the same kind of different-sized kernels one would expect to find the larger-sized kernels harder, and it is quite evident that the larger-sized kernels will also give a greater flour yield. The quality of the flour, however, is quite apart from this general statement.

As between the varieties it is to be noted that the following order is shown; Sonora, Little Club, Australian, and Bluestem. This is quite a different order than would probably be assigned to these grains by a

miller, who would probably place them in the following order from a milling standpoint, Australian, Bluestem, Sonora, Little Club. There is little question but what the above-named figures represent the relative hardness of the varieties when expressed in actual weights, which would make it appear that the action under the rolls involves other factors besides the hardness, for it is the action under the rolls, which the miller has learned from long experience, which is likely to govern him very much when he attempts to judge of hardness by biting the grain; and the difference between the white wheats is so slight, that he is unconsciously influenced almost altogether by the results of his experience with the grains under the rolls, rather than by the real hardness of the kernel.

Indeed, one would expect the Sonora grains to be the harder from their general appearance, and from their usually higher bushel weight. The grains are small and dense, have a thin, smooth, glossy bran and more than make up in weight for what they lack in size, and this greater density is shown in their relative hardness as compared with the other varieties tested.

THICKNESS OF BRAN.

The thickness of the bran is recognized by millers as having more or less to do with the milling characteristics of wheats, and some preliminary work was undertaken in connection with these investigations towards a measurement of the thickness of the bran of the varieties of wheat under trial.

For this preliminary work ten typical heads of White Australian were selected for examination.

Answers to two questions were sought: First, is the thickness of the bran fairly uniform in the same kernel; second, is the thickness of the bran of kernels from different parts of the same head fairly uniform?

Preparation of the Grain.—To toughen the grain for section cutting it was first soaked in water, and then allowed to dry thoroughly on the slide. The section was cleared with clove oil, and to free the preparation from air bubbles the dry section was treated with alcohol just before treatment with clove oil.

The drawing was done by the aid of a camera lucida attachment to the microscope. An outline of the outer and inner edges of the bran was drawn, and the average width determined by measurement. Measurements were made at three points upon each grain on cross sections made at the ovary end of the kernel, at the center and at the beard end of the kernel, about 20 measurements being made upon the bran of each cross section.

In all 60 kernels were thus examined, 2 grains being taken from the top, 2 from the bottom and 2 from the center of each of the 10 heads.

Of these three fourths of the thickest sections were at the beard end of the kernels, but not much variation appeared from the center to the ovary end.

TABLE VII—SHOWING MEASUREMENTS OF THICKNESS OF BRAN IN TEN HEADS OF WHITE AUSTRALIAN WHEAT.

	A.			B.		
	Ovary end.	Middle.	Beard end.	Ovary end.	Middle.	Beard end.
Third kernel from top of head—						
1	2.8	3.3	3.4	2.5	2.4	3.4
2	3.4	3.1	3.6	2.9	2.4	3.3
Middle of head—						
1	3.7	2.7	3.6	2.7	3.6	4.0
2	3.8	3.1	3.2	3.3	2.8	3.0
Third kernel from bottom of head—						
1	3.1	3.4	3.5	2.9	3.1	3.5
2	3.1	3.4	3.8	3.0	2.8	3.5

	C.			D.		
Third kernel from top of head—						
1	3.0	2.9	3.6	2.4	2.8	2.8
2	3.5	3.1	2.8	2.7	2.6	2.9
Middle of head—						
1	2.7	3.1	3.4	2.7	3.1	3.5
2	2.6	2.9	3.8	3.3	2.9	2.7
Third kernel from bottom of head—						
1	3.0	3.9	2.9	2.7	3.3	3.5
2	3.1	3.0	3.6	2.8	2.7	2.9

	E.			F.		
Third kernel from top of head—						
1	2.6	2.8	2.7	2.9	2.8	3.7
2	2.6	3.1	2.7	2.7	2.6	3.3
Middle of head—						
1	2.6	3.0	3.6	3.2	3.3	3.3
2	2.4	2.9	3.1	3.0	3.1	3.8
Third kernel from bottom of head—						
1	2.5	3.3	3.5	2.9	3.7	3.3
2	2.7	3.2	3.5	2.5	2.9	3.1

	G.			H.		
Third kernel from top of head—						
1	3.0	2.7	3.2	3.3	2.8	3.3
2	2.9	2.5	3.7	2.6	2.4	3.2
Middle of head—						
1	3.3	3.8	4.0	3.5	3.4	3.9
2	3.3	3.2	3.7	3.0	3.0	3.5
Third kernel from bottom of head—						
1	3.0	3.0	3.5	2.9	3.3	3.6
2	3.1	3.0	3.8	3.7	3.4	3.3

TABLE VII—*Continued.*

	I.			J.		
	Ovary end.	Middle.	Beard end.	Ovary end.	Middle.	Beard end.
Third kernel from top of head—						
1	2.5	3.2	3.5	2.6	3.2	3.9
2	2.8	2.6	3.0	2.8	2.8	3.1
Middle of head—						
1	2.9	2.8	3.9	3.0	2.8	3.9
2	2.9	2.9	3.6	3.2	3.1	3.5
Third kernel from bottom of head—						
1	2.7	3.3	2.9	2.9	3.0	3.5
2	2.3	3.0	3.6	2.9	3.0	3.2

Collecting these results so as to show the variation a little more closely by averaging the measurements for each of the two grains from the several heads we have as follows:

Third Kernels from Top of Head.

Head.	A	B	C	D	E	F	G	H	I	J	Average.
Kernel No. 1	3.16	2.76	3.16	2.66	2.70	3.13	2.96	3.13	3.06	3.23	2.995
Kernel No. 2	3.33	2.86	3.13	2.73	2.80	2.86	3.03	2.73	2.80	2.90	2.917
Average	3.14	2.81	3.09	2.69	2.75	2.99	2.99	2.92	2.93	3.06	2.956

Middle Kernels.

Kernel No. 1	3.33	3.30	3.06	3.10	3.06	3.26	3.90	3.60	3.20	3.23	3.284
Kernel No. 2	3.33	3.03	3.10	2.96	2.80	3.30	3.40	3.16	3.13	3.26	3.147
Average	3.33	3.16	3.08	3.03	2.93	3.18	3.55	3.38	3.16	3.24	3.215

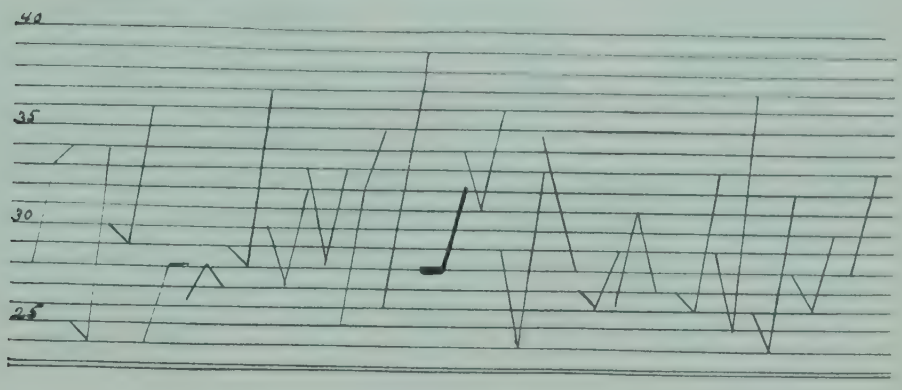
Third Kernel from Bottom of Head.

Kernel No. 1	3.33	3.10	3.26	3.16	3.10	3.30	3.16	3.26	2.96	3.13	3.176
Kernel No. 2	3.43	3.23	3.23	2.80	3.13	2.83	3.30	3.46	2.96	3.03	3.140
Average	3.38	3.16	3.19	2.32	3.11	3.06	3.23	3.36	2.96	3.08	3.158

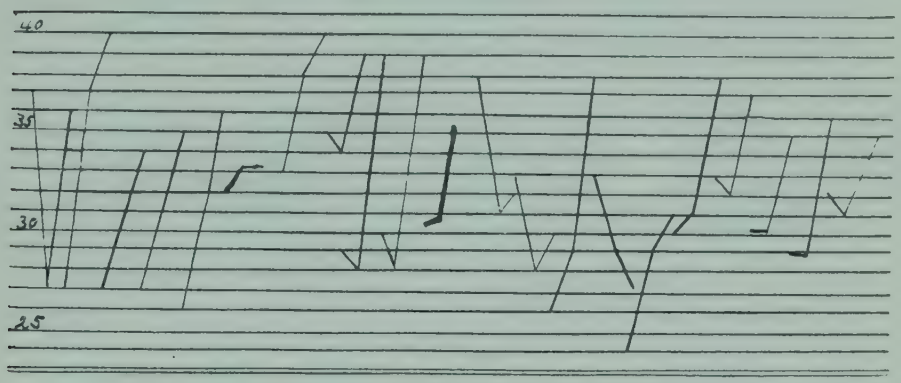
These figures indicate that there is considerable variation in the thickness of the bran on different parts of the same kernel, and that the bran from kernels on the center of the head is thicker than in kernels from either end.

Chart showing Thickness of Bran of White Australian Wheat.

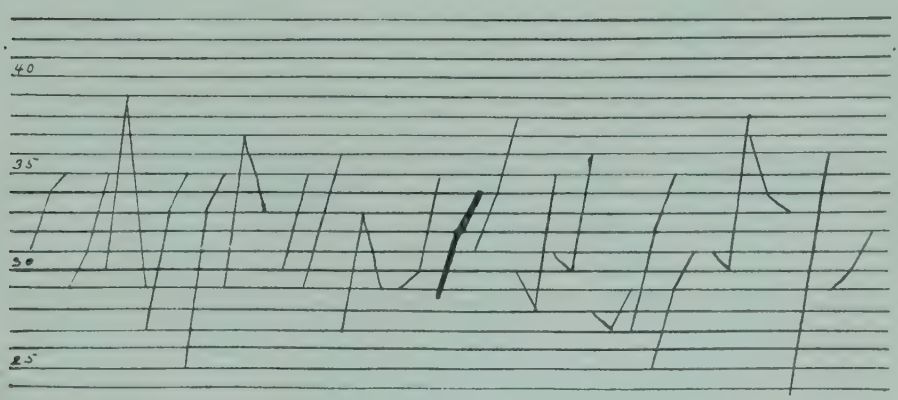
Third Kernel from Top of Spike



Middle Kernel



Third Kernel from Bottom of Spike.



Similar measurements were made in the case of Little Club, which gave the following average results:

	Ovary end.	Center.	Beard end.	Average.
Top of head	3.0 −	3.3 −	3.4 +	3.23
Middle of head	3.1 −	3.3 +	3.6	3.33
Bottom of head	3.1 −	3.3 −	3.5 +	3.30
Mean	3.06	3.30	3.50	3.29

Here again the same facts appear as in the case of White Australian, namely, as to the individual kernel, the bran was the thickest at the brush end; and with reference to the location on the spike, the thickest bran was found on the kernels from the middle of the head.

THE CHEMICAL COMPOSITION OF WHEATS.

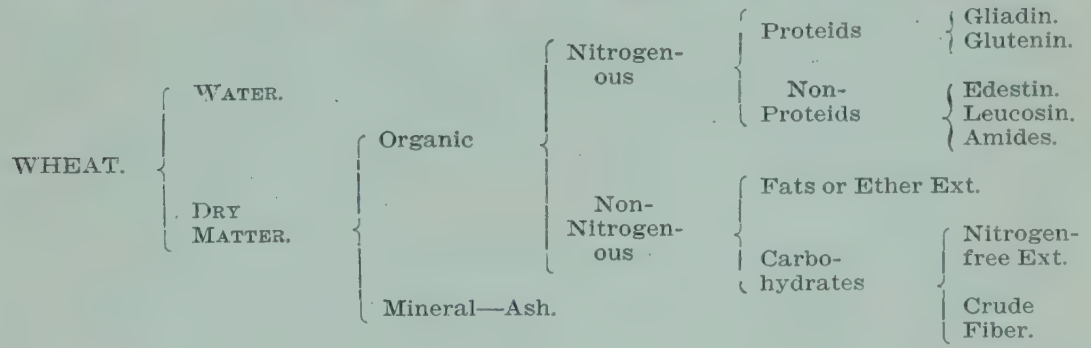
The question of the relation of the chemical composition of wheats to their baking or milling value has been one which has attracted the attention of chemists both in this country and abroad for many years, but up to the present time its complete solution has baffled their skill. While this is true, some advance has been made and certain factors which undoubtedly have a bearing upon their quality as related to baking have been determined; but, nevertheless, it must be admitted that we are still far from a very intimate understanding of the true relation of these factors. It is probably unnecessary to devote any space to a discussion of the real practical value which chemical data would have, provided they could be correlated on a correct basis with the baking value of wheat or flour.

It is not likely that they would have a very close relation to the milling value except as such value is related to the baking value, because the milling value *per se* may be quite independent of the baking value of the flour. The milling qualities of a wheat are almost entirely dependent upon the physical characteristics of the grain, while the baking characteristics of the flour are evidently quite closely related to certain chemical factors. The miller is primarily interested in a large yield of flour of good appearance, while the prime question with the baker is that the flour shall have a sufficient "strength" for his special purpose. A wheat may have excellent milling qualities and still yield a flour quite unsatisfactory to the consumer, and vice versa. The former condition is far too often the case with the California wheats,

and this was the basal reason for the inauguration of the cereal investigation in which this Station is now engaged.

It is quite obvious, then, that the term "strength" and "quality" are not interchangeable, but have quite distinct meanings. The former refers to something which is rather definite in nature, notwithstanding we have not as yet fully ascertained what are the factors which determine the so-called "strength." The "quality" of a flour depends much upon the purpose for which it is intended. It may be very high for pastry, but very poor for bread. A flour which has very high "strength" is usually of lower "quality" for pastry purposes than one of much lower strength. On the other hand, high "strength" is extremely desirable, and well-nigh essential, for the making of good light bread, or macaroni.

The general composition of wheats does not differ materially from that of other organic bodies, in that it is made up of several different groups of constituents, viz., moisture, ash, crude protein, fats, and carbohydrates. These are not distinct and separate compounds, but are groups of bodies having similar properties or food value within each group. Thus, for instance, the term carbohydrates is a general term, embracing a large number of substances, as sugars, starches, certain gums, etc., while protein is the name of a general class of bodies containing nitrogen as an essential ingredient, examples of which are albumin or the white of eggs, the lean meat of animal bodies, the gluten of flour, etc. The composition may be graphically represented as follows:



In all cases water is present. In many instances this is very evident, as in grass, beets, turnips, etc., while in other material it is not so evident, yet when they seem perfectly dry under ordinary conditions, there is from 5 to 10 per cent. moisture present. This water has no more food value than that taken from wells or streams. It is, however, a necessary constituent of organic material. Moisture is determined in the laboratory by heating the material for a long time at the temperature of boiling water.

After the moisture has been driven off there is left the *dry matter*, which is partly organic and partly mineral in its composition.

The mineral matter of plants is expressed by the term *ash*. It is the residue left after burning to perfect whiteness.

The organic matter embraces two well-marked classes, viz., those containing the element nitrogen, *nitrogenous*; and those which lack nitrogen, *non-nitrogenous*. Of all the material composing a foodstuff, the nitrogenous matter is the most important. It embraces both proteids and non-proteids, which, however, are not usually separated, but classed together as *protein*.

The nitrogenous compounds of wheat consist principally of proteids of which five have been recognized and described by Osborne and Voorhees as follows:

1. A globulin, soluble in saline solutions, and not coagulable at a temperature below 100° C. This constitutes 0.6–0.7 per cent. of the grain.

2. An albumin, coagulable at 52° C. It differs from animal albumin in several important particulars. It constitutes from 0.3–0.4 per cent. of the kernel.

3. A proteose, which is extracted from the wheat by dilute saline solutions after removing the globulin by dialysis and the albumin by coagulation. It constitutes 0.2–0.4 per cent of the kernel.

4. Gliadin, a proteid body soluble in dilute alcohol, and forming nearly one half of the total proteid matter of the kernel.

5. Glutenin, which is insoluble in water, dilute saline solutions, and dilute alcohol, and which, together with gliadin, forms nearly the entire proteid content of the wheat kernel.

Gluten.—Chemists divide the above indicated proteids into two general classes, viz., gluten and non-gluten proteids. Gluten is a mixture of gliadin and glutenin. It is the amount and quality of gluten which gives to flour ability to rise into a light and spongy loaf of bread. In the process of bread making, the carbonic acid gas liberated during the fermentation period is imprisoned by the sticky, elastic gluten, and as the gas expands, causes the bread to become porous.

Crude gluten can be obtained either from a wheat meal or flour by washing out the starch and water-soluble portions from a dough made by kneading the meal with water. In this condition it will carry about two thirds of its weight of water and certain impurities which are fairly constant in different samples. "A good gluten has a light yellow color, is tenacious and elastic, while poor gluten is dark in color, sticky but not elastic."*

As the gluten of wheat is that constituent which causes the flour to be strong, wheats to be of high baking quality should carry a high percentage of gluten. This high percentage of itself, however, is not sufficient, since it is found that *glutens differ much in quality,* some are tough and elastic and others not. Again the latter generally are able

* Hunt's Cereals in America, page 41.

to retain a very much smaller amount of water, resulting in a correspondingly less number of loaves per barrel of flour. *To be of high quality a gluten should be highly elastic.*

It has been claimed by some writers that the quality of a gluten is much dependent upon the proportion of the gliadin and the glutenin present. M. E. Fleurent, a French investigator, states that the most favorable ratio of gliadin to glutenin in flour is 75 to 25. Snyder, formerly of the Minnesota Experiment Station, states that 80 to 85 per cent of the total protein should be gluten, and of this the proportion of gliadin to glutenin should be 60 to 65 per cent.

Later work of Snyder, however, seems to cast some doubt as to the value of this matter of proportion of gliadin to glutenin, for, in 1905, a year later than the former statement, he writes: "As our work on this point extends over a number of years it appears that *it is more a question of total gliadin than the ratio of gliadin to glutenin.*" The results presented in the later pages of this bulletin seem to bear out this latter statement of Snyder and to cast grave doubt upon the possibility of correlating the gliadin-glutenin ratio closely with the bread-making value of a wheat or flour.

Fats.—Nearly all foodstuffs contain more or less *fat.* Here, again, the term is not used in as definite a sense as in ordinary language, but rather refers to a class of bodies which have a similar composition, and since they are determined by extraction with ether, many chemists prefer to use the name *Ether Extract.* It really denotes more than fat in the case of green foodstuffs, as the coloring matter and certain gums are extracted at the same time, but in grain the extract is nearly all fats and oils. These do not differ in any essential particular from the animal fats and oils, which all belong to a class of bodies known as glycerides. The fat of wheat is not a very important element in determining its value.

The *Carbohydrates* are usually separated into *Crude Fiber,* and another class called *Nitrogen-free Extract.* The former is the woody tissue of the plant, which remains after successive boilings with a weak acid and a weak alkali. It is found principally in the bran. Carefully conducted experiments show that even this woody fiber has a nutritive value, a small quantity usually being digested. Still the value of foodstuffs usually varies inversely as the amount of crude fiber present. The *Nitrogen-free Extract* is composed of a number of substances as starch, sugar, dextrin, and gums, grouped together because similar in composition.

Starch is the most important of the carbohydrates of wheat and constitutes from 64 to 70 per cent. of the kernel. It is, of course, of great importance as the principal foodstuff in bread. *Sugar* and *dextrin* are

other compounds which are present in wheats in quite small quantities. In sound wheat if sugar be present it should be in the form of cane sugar. Should, however, the sugar be in the form of maltose it would undoubtedly indicate a partial hydrolysis of starch and would be objectionable. The same may be said with regard to the presence of dextrin.

Incomplete as are the present laboratory methods, they still furnish results of considerable value in a broad classification of wheats and flours, even if failing to distinguish between two samples of approximately the same "strength."

With the idea of obtaining more information relative to the chemical characteristics of the common California white wheats, the samples discussed previously, as well as some others, were subjected to chemical analysis.

THE METHODS FOR CEREAL ANALYSIS.

The methods of analysis adopted for this work were adapted from those given in Bulletin 107, of the Bureau of Chemistry, United States Department of Agriculture, and the work of Teller, and are set forth below.

Moisture.—Dry 2 to 3 grams of the material for five hours at the temperature of boiling water. Use the aluminum moisture dishes provided for this purpose. (Note.—If fat is to be determined the dried material from the moisture determination can be used.)

Ash.—Char 2 grams of the material, if a wheat meal, or 3 grams if a flour, and burn to whiteness at the lowest possible red heat. If a white ash can not be obtained in this manner, exhaust the charred mass with water, collect the insoluble residue on a filter, burn, add this ash to the residue from the evaporation of the aqueous extract, and heat the whole to a low redness till the ash is white or nearly so. Great care has to be taken with these wheat products not to overheat at the start. It must under no circumstances be fused if phosphoric acid is to be determined in the ash, otherwise fusing is allowable, the loss being so small as to be negligible.*

* Leavitt & Le Clerc, "Loss of Phosphoric Acid in Ashing Cereals," Jour. Am. Chem. Soc., Vol. XXX, No. 3, p. 391.

SCHEME FOR NITROGEN DETERMINATION.

The basal scheme for nitrogen determination for various protein compounds is as follows:

Determine total nitrogen	x
Determine non-gluten nitrogen (= salt soluble N. — constant *)	y
Difference = gluten nitrogen	$= x - y$
Determine gliadin nitrogen (=alcohol soluble)†	z
Difference=glutenin nitrogen	$= (x - y) - z$

* Constant for soft wheat meals=.15.
Constant for durum wheat meals=.20.
Constant for flour=.22.

These constants represent the average amount of gliadin nitrogen that will be found in the salt solution.

† Strictly speaking, the gliadin nitrogen should be corrected for the amid nitrogen present, but for most practical purposes this may be neglected.

Detailed Outline of Methods.

Total Nitrogen—Gunning Method: In a digestion flask (Kjeldahl) place one gram of the material to be analyzed. Add 10 g. of powdered potassium sulfate and about 20 cc. of concentrated sulfuric acid. Digest as in the ordinary Kjeldahl process, starting with a comparatively low temperature and gradually increasing. Digest until the mixture is colorless. Do not add either potassium permanganate or potassium sulfid. Dilute, neutralize and distil as in Kjeldahl method. In neutralizing it is convenient to add a few drops of phenolpthalein to serve as an indicator.

Use 10 cc. n/4 hydrochloric acid, dilute with an equal volume of water for collecting the ammonia and distil off about three fourths of the contents of the distillation flask. Use n/10 ammonia for titrating back the acid, with cochineal as an indicator.

NOTE.—For further details see Official Method, Bul. 107, page 7.

(2) Total Proteids. Nitrogen determined as above x 5.68 = total proteids.

(3) *Gliadin.* Weigh out 2 gms. of flour into a small flask holding somewhat more than 100cc. Add 100 cc. of 70 per cent. alcohol and shake thoroughly for 15 minutes. Allow to stand 18 hours and filter into a Kjeldahl digestion flask with a short neck. Wash the residue with 100 cc. of 70 per cent. alcohol. Add to the total filtrate 10 cc. of concentrated sulfuric acid and distill off the excess of alcohol, continuing the distillation until fumes appear. Add 10 cc. more of concentrated sulfuric acid and finish the determination of nitrogen by the Gunning method. The *nitrogen* × *5.68 = proteid soluble in alcohol.*

With old and unsound flours a correction must be made for soluble amid bodies.

(4) *Non-Gluten Nitrogen.* Place 4 grams of the material in a 200 cc. flask. Add about 15 cc. of a 1 per cent. solution of sodium chlorid and shake thoroughly. To the resulting homogeneous mass, add enough of the same solution to make exactly 100 cc. of the salt solution as a total amount. Shake the contents of the flask in a shaker for 6 hours. After allowing it to stand over night to settle, filter off 50 cc. of the liquid through a 12½ cm. dry filter, pouring back the first portion of the filtrate until it filters clear and determine the nitrogen therein by the Gunning method. On collecting this 50 cc. with a few cubic centimeters of washings in a Kjeldahl flask and adding 20 cc. concentrated sulfuric acid, the water can readily be boiled off, especially if the flask be protected from the naked flame. When the acid ceases to foam it is cooled slightly, sulfate of potash added and the nitrogen determination completed in the usual way. After adding the sulfate of potash, the time required for the digestion is but a few minutes.

A small percentage of gliadin nitrogen will be included in the above determination. Experience has shown that this amounts to about .15 per cent. for white wheat meals and is quite constant. This factor (.15%) should be subtracted from the nitrogen per cent., as determined in the above procedure. For factors to use with other wheats see page 344. The difference is called *Non-gluten Nitrogen.* The protein corresponding to this nitrogen is calculated by multiplying by 5.68.

(5) *Glutenin.* For most purposes the difference between the gluten nitrogen and the gliadin nitrogen, as determined above, may be considered glutenin nitrogen. For more accurate work, however, the glutenin nitrogen may be determined as follows:

The residue from the gliadin determination is washed with 70 per cent. alcohol until the washings no longer react for proteids. Transfer it to a flask and add 200 cc. of a 5 per cent. solution of sodium chlorid to remove globulin and other proteids. After two hours extraction the residue is washed with distilled water and transferred to a flask, 250 cc. of a 2 per cent. solution of potassium hydroxid added and after 3 hours' extraction the solution is filtered and the nitrogen determined in 200 cc. of the filtrate in the usual way.

(6) *Amid Nitrogen.* From 100 cc. of the salt extract precipitate all the proteids by adding 10 cc. of a ten per cent. solution of phospho-wolframic acid, made by dissolving the pure solid in distilled water. (*Note.* In case of bran, it may be necessary to add more of the phospho-wolframic solution.) Allow to settle before filtering and determine the nitrogen in the clear filtrate. In order to secure a clear filtrate it will doubtless be necessary to allow the solution to stand over night in order to obtain a clear supernatant liquid. On collecting this (50 or 100 cc. with a few cubic centimeters of washings) in a Kjeldahl flask and adding 20 cc. of concentrated sulfuric acid the water can be readily boiled off, especially if the flask be protected with a thin sheet of asbestos. When the acid ceases to foam it is cooled slightly, sulfate of potash added and the nitrogen determination completed in the usual way. After adding the sulfate the time required for digestion is but a few minutes.

(7) *Edestin and Leucosin Nitrogen.* To 50 cc. of the clear salt extract, obtained as described above, add, in a 500 cc. Kjeldahl digestion flask, 250 cc. of pure 94 per cent. alcohol (188 per cent. proof, re-distilled). Mix thoroughly and allow to stand over night. Collect the precipitate on a filter (10 cm.) of good quality, return to the flask, and determine the nitrogen, making proper correction for nitrogen in the filter.

NOTE.—If desired these two proteids may be separated by coagulating the leucosin at 60°C. and precipitating the edestin by adding alcohol to 50 cc. of the clear filtrate as before. The nitrogen in each precipitate may then be determined.

(8) *Baker's Sponge Test.*—100 grams of flour are weighed into a wide porcelain dish or bowl. A part of the water (50 to 65 cc.) necessary to make a stiff dough is run in from a burette. In this is dissolved 5 g. of sugar and 5 g. of compressed yeast. The flour is then stirred in with steel spatula and more water added until dough of standard stiffness is obtained. Amount of water used for dough recorded.

The dough is now placed in tubes of about 4 inch diameter, graduated into cubic centimeters. These tubes are now set in water at 90°F. and the dough allowed to rise. It must be constantly watched until the maximum height is reached and the dough falls, when the time required to rise and the volume in cubic centimeter is recorded. This is repeated and the volume and time again recorded.

By dividing the volume of loaf, to which 100 grams of flour rises, by the percentage of gluten in the flour, the volume of loaf produced by each gram of gluten is found.

(9) *Acidity.*—In a porcelain casserole place 5 grams of flour, and gradually mix with about 50 cc of distilled water freed from carbon dioxid by previous boiling. When a perfectly homogeneous mixture has been obtained add a few drops of phenolpthalein, and titrate with n/50 NaOH. It is unnecessary to filter previous to titration. Calculate results to sulfuric acid.

(10) *Wet Gluten.*—Weigh out 25 grams of the sample, moisten with 15 to 18 cubic centimeters of water, knead to a stiff dough. Work thoroughly so as to bring all gluten into active contact. Allow to stand for one hour. Holding the mass in the hand under a slow stream of cold water gently pull and knead at the same time until the starch and all soluble matters are washed out. It is well to conduct the work over a fine sieve to prevent the loss of small particles of gluten. Then place in cold water and allow to stand for one hour, finally remove from the water, knead well in the hands, frequently drying the hands upon a towel. During the kneading of the gluten, manipulate it in such a way as to ultimately bring all parts of the gluten on the outside. When all the free water has been removed, roll the mass into a ball and weigh either upon a counterpoised card or in a flat-bottom dish. Note should be made of the color and general stiffness as shown by the way it stands up upon the card. The stiffer the gluten the more globular the mass.

(11) *Dry Gluten.*—After weighing, introduce the ball of wet gluten into a drying oven at a temperature of boiling water and try to constant weight. The time required will be not less than fifteen hours, cool and weigh.

(12) *Water Capacity.*—The difference between wet and dry gluten equals the water holding power. Record this, as one part gluten holds x parts of water.

(13) *Ether Extract.*—(Fat) Extract from 2 to 3 grams of the substance used for the determination of moisture, with anhydrous alcohol-free ether for sixteen hours. Filter off the solid residue through a small filter paper into a tared flask. Distil off the ether, and dry the extract to constant weight. This work is most conveniently done in a small wide-mouthed Erlenmeyer flask.

Or, the residue can be collected in a tared Gooch filter, dried as in the moisture determination, and the loss in weight regarded as ether extract.

NOTE.—The ether used for this work must be strictly anhydrous. To prepare this, wash any of the commercial brands of ether with two or three successive portions of distilled water, and add solid caustic potash or soda until most of the water has been abstracted from the ether. The final traces of moisture can be removed by adding to the partially dried ether carefully cleaned metallic sodium, cut in small pieces, until no more hydrogen gas is evolved. The dehydrated ether should be kept over metallic sodium.

A TRIAL OF THE POLARISCOPIC METHOD FOR THE DETERMINATION OF GLIADIN.

The use of the polariscope has been suggested for the determination of gliadin in cereal products as offering a method which would reduce the time required by the ordinary Gunning-Kjeldahl operation, and at the same time be sufficiently accurate for technical purposes.

With the idea of satisfying ourselves upon the applicability of the method, as applied to the products in hand, comparative trials of this method were made against the ordinary Gunning-Kjeldahl procedure.

This is more rapid than the regular method and is recommended for general work when there is sufficient material. Weigh out 15.97 grams of the material and digest over night in 100 cc. 70 per cent alcohol.

The flask should be agitated thoroughly at intervals of one half-hour for a period of two hours. Filter to a clear solution, protecting from evaporation as much as possible. Polarize in a 220 mm. tube. The reading will probably be a minus one. Correct for sugar by adding to 50 cc. of the filtrate sufficient mercuric chlorid (concentrate solution) to precipitate all the proteids: Make to 55 and polarize again.

The range of material covered by these trials was somewhat different than those mentioned in the original article by Snyder.* The first series of analyses were made upon soft wheat meals. The results are set forth below:

Laboratory number.	Gliadin nitrogen calculated to dry matter.		
	By Polariscope method.	By Gunning method.	Difference.
19	0.72	--	--
249	0.56	0.54	+.02
254	0.46	0.49	−.03
257	0.38	4.40	−.02
265	0.42	0.43	−.01
266	0.42	0.44	−.02
268	0.39	0.39	.00
270	0.38	0.43	−.05
288	0.49	0.49	.00
290	0.57	0.64	−.07
313	0.39	0.55(?)	−.16
322	0.39	0.53(?)	−.14
326	0.49	0.50	−.11

The above determinations were made upon soft white wheat meals. In this lot of samples the gliadin determination by the Gunning method had already been made several weeks before the trial of the polariscope method.

Determinations were made by the polariscope method on the basis of the changed moisture content of the sample, and the results in each case calculated to dry matter for comparison. Further, the methods were

* H. Snyder in Jour. Am. Chem. Soc., Vol. XIX, No. 12.

operated by different parties, so there were undoubtedly introduced into the operation greater differences in the manipulation of securing solution of the gliadin than if the two operations had been conducted by the same person. Notwithstanding these sources of error it will be noted, that with the exception of Nos. 313 and 322, concerning which there was previously existing some doubt as to the accuracy of the original determination, the polariscopic method gave results which are within the range of error of most operations.

The above results not being quite satisfactory, the comparison of methods was carried further with the same class of material, the sample operated upon in the one method being taken from the same solution as in the other, one portion being used for polarization and another treated by the Gunning method. The solution of gliadin in these trials was effected by digesting in the cold, as described by Snyder, 15.97 grams of the material in 100 cc. of 70 per cent. alcohol. The flask was shaken at intervals of half an hour for two hours, and left overnight before filtration. Ten cubic centimeters of this solution were used for treatment by the Gunning method, after first driving off the alcohol by evaporation. By this procedure one would expect somewhat closer results than by the former.

SOFT WHEAT MEALS.			FLOUR.		
By Polariscope method.	By Gunning method.	Difference.	By Polariscope method.	By Gunning method.	Difference.
0.90	0.91	− .01	0.77	0.75	+ .02
0.70	0.69	+ .01	0.59	0.57	+ .02
0.86	0.90	− .04	0.51	0.48	+ .03
0.81	0.75	+ .06	0.46	0.43	+ .03
0.64	0.63	+ .01	0.62	0.55	+ .07
0.70	0.70	.00	0.77	0.70	+ .07
0.66	0.69	− .03	0.86	0.84	+ .02
0.92	0.94	− .02			
0.64	0.69	− .05		Average	+0.04
0.95	0.94	+ .01			
0.57	0.59	− .02			
0.55	0.60	− .05	DURUM WHEAT MEALS.		
0.73	0.71	+ .02			
0.62	0.60	+ .02			
0.62	0.66	− .04	0.84	0.83	+ .01
0.53	0.56	− .03	0.77	0.78	− .01
0.90	0.92	− .02	0.95	0.94	+ .01
0.88	0.85	+ .03	0.70	0.76	− .06
0.81	0.78	+ .03	0.66	0.69	− .03
0.70	0.70	.00	0.75	0.75	.00
0.73	0.74	− .01	0.79	0.83	− .04
0.77	0.78	+ .01	0.59	0.62	− .03
0.62	0.60	+ .02	0.81	0.78	+ .03
0.59	0.57	+ .02	0.64	0.64	.00
0.64	0.60	+ .04			
0.64	0.60	+ .04		Average	−0.02
0.55	0.58	− .03			
	Average	−0.03			

In but three cases out of the forty-five last stated does the difference between the two methods exceed 0.05, which is certainly as close as one can expect ordinary technical work to be done, and as between two samples is undoubtedly within the limits of accuracy of sampling large lots.

A still further test of the method was given by making a gliadin determination upon a gluten flour in which the Kjeldahl method showed 3.32 per cent. of gliadin nitrogen. The polariscopic method showed 3.45 per cent.

Considerable difficulty was experienced at the outset in securing a clear solution for filtration, but this was finally overcome by avoiding excessive agitation.

Snyder remarks that in the case of flours analyzed by him, and probably grown in the middle west, "the combined alcohol soluble carbohydrates and non-gliadin proteins of the alcoholic solution affect the polarization to only a slight extent," and states that after the gliadin protein was precipitated the non-gliadin rotary bodies showed a reading of less than 0.20 on the sugar scale.

In our experience with the method it was always found necessary to make two polarizations, the first on the original solution, and the second after separating the protein bodies by the use of a concentrated solution of mercuric nitrate, and then making the required correction to give the true gliadin reading.

This was particularly true in the case of wheat meals where the average difference between the two polariscope readings was 1.05 on the sugar scale corresponding to 0.21 per cent. on the gliadin scale, the range of differences on the sugar scale being from 0.08 to 2.75. In the case of flours, unless extreme accuracy is required, the correction could be neglected inasmuch as the error is much less, not exceeding 0.04 per cent. of the gliadin scale.

The writers are strongly impressed with the idea that the method is worthy of a much more extended use than it has so far had, and that if precautions are taken to correct for the effect of other optically active bodies, there are fewer opportunities for error than with the ordinary method of nitrogen determination.

NITROGEN OF COMPOUNDS SOLUBLE IN ONE PER CENT. SODIUM CHLORID SOLUTION.

Before reaching a decision as to the factor to be subtracted from the nitrogen found in the salt extract, several separations of the nitrogenous ingredients of this extract were made. Teller from his elaborate work upon this point, suggested that the factor .27 per cent. be used, and proceeded upon that basis. In discussing this question he states, however, that "two other samples showing an unusually low difference (that is, gliadin per cent. in salt extract. G. W. S.) are white wheats, each of

which contains a very low per cent. of gliadin." He also intimates that another factor than .27 might be preferable for such wheats. It was with the idea of ascertaining what this factor should be that the separation of the protein compounds was undertaken.

The procedure followed was as set forth under the portion of this bulletin headed "Methods of Analysis of Cereal Products."

First of all, to ascertain the effect of different methods of shaking to secure solution of the compounds, comparative trials were made (1) by shaking at intervals of half hours for a period of six hours, and (2) shaking in a mechanical shaker continuously for a period of six hours, the results are given in detail in the following table:

TABLE VIII.—SHOWING NITROGEN COMPOUNDS IN WHEAT MEALS SOLUBLE IN ONE PER CENT SODIUM-CHLORID SOLUTION.

Hard Wheat Meals.

Number	How Treated.	Moisture.	Total nitrogen	Edestin nitrogen	Amid nitrogen	Gliadin nitrogen	Gliadin nitrogen calc. to dry matter.
723	Shaken at intervals for 6 hours	11.07	.43	.17	.06	.20	.224
723	Shaken continuously for 6 hours	11.07	.53	.21	.06	.26	.291
724	Shaken at intervals for 6 hours	10.70	.49	.17	.07	.25	.280
724	Shaken continuously for 6 hours	10.70	.53	.24	.06	.23	.257
727	Shaken at intervals for 6 hours	10.61	.42	.22	.06	.14	.159
727	Shaken continuously for 6 hours	10.61	.49	.20	.06	.23	.257
728	Shaken at intervals for 6 hours	10.56	.46	.23	.06	.17	.190
728	Shaken continuously for 6 hours	10.56	.51	.20	.07	.24	.269
731	Shaken at intervals for 6 hours	10.40	.48	.20	.08	.20	.223
731	Shaken continuously for 6 hours	10.40	.52	.21	.07	.24	.269
735	Shaken at intervals for 6 hours	10.70	.45	.21	.08	.16	.179
735	Shaken continuously for 6 hours	10.70	.51	.20	.06	.25	.280
	Average at 6-hour intervals	10.67	.45	.20	.07	.19	.209
	Average continuous shaking	10.67	.51	.21	.06	.24	.270

Soft Wheat Meals.

232	Shaken at intervals for 6 hours	11.42	.41	.16	.08	.17	.191
232	Shaken continuously for 6 hours	11.40	.35	.14	.07	.14	.158
237	Shaken at intervals for 6 hours	11.52	.39	.17	.08	.14	.158
237	Shaken continuously for 6 hours	11.49	.39	.14	.08	.17	.192
240	Shaken at intervals for 6 hours	11.85	.35	.15	.07	.13	.147
240	Shaken continuously for 6 hours	11.90	.42	.18	.08	.16	.181
242	Shaken at intervals for 6 hours	11.36	.46	.17	.08	.21	.236
242	Shaken continuously for 6 hours	11.32	.48	.18	.07	.23	.259
245	Shaken at intervals for 6 hours	10.73	.43	.17	.07	.19	.212
245	Shaken continuously for 6 hours	11.75	.42	.15	.07	.20	.226
246	Shaken at intervals for 6 hours	10.70	.35	.15	.05	.15	.160
246	Shaken continuously for 6 hours	10.75	.41	.18	.07	.16	.179
	Average at intervals for 6 hours	10.27	.40	.16	.07	.16	.187
	Average continuous shaking	11.43	.41	.16	.07	.18	.199

Soft Wheat Flours.

Number	How Treated.	Moisture.	Total nitrogen	Edestin nitrogen	Amid nitrogen	Gliadin nitrogen	Gliadin nitrogen calculated to dry matter.
19, 24	Shaken at intervals for 6 hours	10.99	.36	.12	.03	.21	.235
19, 24	Shaken continuously for 6 hours	10.99	.36	.10	.04	.22	.250
248	Shaken at intervals for 6 hours	11.35	.36	.12	.03	.21	.237
248	Shaken continuously for 6 hours	11.35	.36	.11	.03	.22	.249
266	Shaken at intervals for 6 hours	11.25	.31	.09	.03	.19	.214
266	Shaken continuously for 6 hours	11.25	.31	.08	.03	.20	.226
268	Shaken at intervals for 6 hours	11.13	.29	.09	.02	.18	.202
268	Shaken continuously for 6 hours	11.13	.31	.08	.03	.20	.225
288	Shaken at intervals for 6 hours	10.40	.36	.12	.03	.21	.245
288	Shaken continuously for 6 hours	10.40	.38	.10	.03	.25	.279
512	Shaken at intervals for 6 hours	10.70	.41	.12	.02	.27	.302
512	Shaken continuously for 6 hours	10.70	.41	.13	.04	.24	.272
	Average at 6-hour intervals	10.97	.35	.11	.03	.21	.237
	Average for 6 hours shaking	10.97	.35	.10	.03	.22	.250
	General average, intervals	10.64	.40	.16	.06	.19	.211
	General average, continuous	10.64	.42	.16	.05	.21	.239

An examination of this table shows that the continuous shaking would have given slightly higher results, but they would not have been materially changed by such procedure, and so far as the general run of technical work is concerned the interval shaking is doubtless entirely satisfactory.

Adopting as the basis of the work the classification of the proteids of wheat as previously set forth, a nextract was obtained from 4 grams of finely ground wheat meals by means of a 1 per cent. sodium chlorid solution and aliquot portions used for the direct determinations of total nitrogen, edestin and leucosin nitrogen, and of amid nitrogen. The difference between the sum of these, and the total, was presumed to represent gliadin nitrogen that had been dissolved by the salt solution. Throughout this work the shaking was done at intervals of a half hour for a period of six hours.

TABLE IX.—SHOWING NITROGEN OF COMPOUNDS SOLUBLE IN ONE PER CENT SODIUM CHLORID SOLUTION.

Number	Name.	Moisture.	Total nitrogen.	Edestin and leucosin nitrogen.	Amid nitrogen.	Gliadin nitrogen.	Gliadin nitrogen calc. to dry matter.
205	Wheat meal	12.00	.35	.16	.08	.11	.125
205	Wheat meal	11.89	.37	.16	.08	.13	.147
	Average	11.945	.36	.16	.08	.12	.136
206	Wheat meal	12.28	.38	.17	.10	.11	.125
206	Wheat meal	12.21	.37	.17	.10	.10	.114
	Average	12.245	.375	.17	.10	.105	.1195
212	Wheat meal	11.63	.46	.17	.15	.14	.158
212	Wheat meal	11.55	.45	.17	.16	.12	.135
	Average	11.59	.455	.17	.155	.13	.1465
231	Wheat meal	11.85	.36	.17	.06	.13	.147
231	Wheat meal	11.68	.39	.17	.07	.14	.158
	Average	11.765	.375	.17	.065	.135	.1525
232	Wheat meal	11.42	.41	.16	.08	.17	.191
232	Wheat meal	11.37	.38	.14	.10	.13	.146
	Average	11.395	.395	.15	.09	.15	.1685
233	Wheat meal	11.66	.46	.20	.09	.17	.190
233	Wheat meal	11.84	.48	.20	.09	.18	.207
	Average	11.75	.47	.20	.09	.175	.1985
237	Wheat meal	11.52	.39	.17	.08	.14	.158
237	Wheat meal	11.46	.41	.19	.09	.13	.146
	Average	11.49	.40	.18	.085	.135	.152
242	Wheat meal	11.36	.46	.17	.08	.21	.236
242	Wheat meal	11.28	.46	.17	.08	.19	.214
	Average	11.32	.46	.17	.08	.20	.225
245	Wheat meal	10.73	.43	.17	.07	.19	.212
245	Wheat meal	10.77	.42	.17	.07	.18	.201
	Average	10.75	.425	.17	.07	.185	.2065
240	Wheat meal	11.85	.35	.15	.07	.13	.147
240	Wheat meal	11.95	.34	.15	.07	.12	.136
	Average	11.90	.345	.15	.07	.125	.1415
246	Wheat meal	10.70	.35	.15	.05	.15	.160
246	Wheat meal	10.81	.35	.14	.06	.15	.160
	Average	10.755	.35	.145	.065	.15	.160
247	Wheat meal	11.30	.41	.15	.06	.20	.225
247	Wheat meal	11.54	.39	.14	.06	.19	.214
	Average	11.42	.40	.145	.06	.195	.2195
248	Wheat meal	11.02	.35	.15	.04	.16	.179
248	Wheat meal	10.97	.36	.12	.05	.19	.213
	Average	10.995	.355	.135	.045	.175	.196
249	Wheat meal	11.10	.34	.14	.05	.15	.167
249	Wheat meal	10.95	.35	.13	.06	.16	.179
	Average	11.025	.345	.135	.055	.155	.173
254	Wheat meal	11.02	.35	.12	.05	.18	.202
254	Wheat meal	10.66	.34	.12	.05	.17	.192
	Average	10.84	.345	.12	.05	.175	.197
	Grand average soft wheat meals	11.41	.39	.16	.076	.154	.173

TABLE IX (*continued.*)

Number	Name.	Moisture.	Total nitrogen.	Edestin and leucosin nitrogen.	Amid nitrogen.	Gliadin nitrogen.	Gliadin nitrogen calc. to dry matter.
721	Hard wheat meal	10.71	.45	.19	.06	.20	.223
721	Hard wheat meal	10.71	.43	.17	.06	.20	.223
	Average	10.71	.44	.18	.06	.20	.223
722	Hard wheat meal	10.78	.43	.19	.06	.18	.201
723	Hard wheat meal	11.07	.43	.17	.06	.20	.224
724	Hard wheat meal	10.70	.49	.17	.07	.25	.28
727	Hard wheat meal	10.61	.42	.22	.06	.14	.159
728	Hard wheat meal	10.56	.46	.23	.06	.17	.190
729	Hard wheat meal	10.46	.48	.22	.07	.19	.212
731	Hard wheat meal	10.40	.48	.20	.08	.20	.223
735	Hard wheat meal	10.70	.45	.21	.08	.16	.179
	Grand average hard wheat meals	10.66	.45	.201	.066	.189	.20
19, 24	Flour	10.99	.36	.12	.03	.21	.235
248	Flour	11.35	.36	.12	.03	.21	.237
266	Flour	11.25	.31	.09	.03	.19	.214
268	Flour	11.13	.29	.09	.02	.18	.202
288	Flour	10.40	.36	.12	.03	.21	.245
512	Flour	10.70	.41	.12	.02	.27	.302
513	Flour	10.90	.39	.13	.02	.24	.266
	Grand average flour	10.97	.354	.11	.025	.215	.243

From these results it was decided to use the factor .15 per cent. as representing more nearly the gluten constituents, which pass into the salt solution in the treatment of soft wheat meals, than the one suggested by Teller, in the case of the so-called hard wheats. The other work indicates, however, that a somewhat higher factor should be used for the hard winter and durum wheats, and a still higher factor for flours. The markedly higher factor for flours undoubtedly is brought about from their finer condition. Even here, however, the factor appears to be lower than that suggested by Teller (.27), for in but one case out of the entire number did the figures rise as high as that.

DISCUSSION OF ANALYSIS OF WHOLE WHEAT.

Previous to analysis the samples were all held in the storeroom under uniform conditions for several weeks to secure greater uniformity in moisture condition. Each sample was freed from all foreign matter, such as weed seed, chaff, pieces of straw, dirt, etc., previous to being ground to a fine meal for analysis. The analysis of plump kernels only is recorded in these tables and in this respect the samples are strictly comparable. For the better comparison of results all the chemical data has been calculated to the basis of dry matter, but the percentage of moisture in the original is recorded in each case.

It is of particular interest in the first place to compare the several varieties one with another. At the bottom of each table of varieties is given the average for each of the respective varieties. The averages are also set forth in a separate table (Table XIV).

TABLE X.—SHOWING CHEMICAL CHARACTERISTICS OF WASHINGTON BLUESTEM WHEAT.

Number of sample.	Physical.		Chemical.										
				Calculated to dry matter.									
					Gluten.								
					Gliadin.		Glutenin.						
	Number kernels in 10 grams.	Relative hardness.	Moisture.	Total protein.	Per cent of wheat.	Per cent of total protein.	Per cent of wheat.	Per cent of total protein.	Total per cent of wheat.	Gliadin-glutenin ratio.	Non-gluten protein.	Ash.
61	225	437	12.80	10.14	4.20	41.48	4.05	40.00	8.25	51-49	1.89	2.05
606	231	445	12.57	10.30	3.28	31.96	5.45	52.94	8.73	38-62	1.57	----
118	237	408	12.69	10.68	4.20	39.33	4.92	46.09	9.12	44-56	1.56	2.13
17	242	237	11.76	11.91	5.33	44.81	3.08	25.88	8.41	63-37	3.50	2.13
24	242	222	11.48	11.51	6.30	54.76	3.47	30.22	9.77	64-36	1.74	2.12
25	243	193	12.64	13.87	4.65	33.58	7.07	50.99	11.72	40-60	2.15	2.03
152	245	287	13.36	10.26	4.15	40.58	4.53	44.21	8.68	48-52	1.58	2.14
9	257	231	10.23	9.05	3.55	39.23	2.90	32.10	6.45	55-45	2.60	2.02
303	263	367	9.68	9.31	3.17	34.13	4.86	52.2	8.03	39 61	1.28	----
121	267	342	11.81	9.01	3.57	39.13	4.01	43.97	7.58	47 53	1.43	1.95
268	268	260	12.14	7.29	2.54	34.95	3.39	46.55	5.93	43-57	1.36	1.99
196	270	----	9.18	10.18	3.63	35.67	5.05	49.62	8.68	42 58	1.50	1.97
172	271	353	13.72	12.26	3.88	31.4	6.84	55.34	10.72	36-64	1.54	1.80
15a	277	291	12.84	9.27	3.04	32.85	4.79	51.66	7.83	39-61	1.44	2.14
10a	277	247	11.89	8.76	2.89	33.03	4.36	49.87	7.25	40-60	1.51	1.98
10	277	----	11.77	12.14	4.47	37.92	4.72	39.05	9.19	49-51	2.95	2.09
16	279	171	11.27	10.94	5.78	51.69	1.96	17.92	7.74	74 26	3.20	2.18
15	280	171	11.01	10.91	5.02	46.03	2.42	22.24	7.44	67 33	3.47	2.26
1	285	167	11.27	8.98	4.31	48.05	3.44	38.39	7.75	56 44	1.23	2.20
14	287	218	11.22	12.79	5.83	45.59	3.49	27.29	9.32	63-37	3.45	2.25
13	289	----	10.80	11.15	4.29	38.49	3.67	32.96	7.96	54-46	3.19	2.06
391	297	----	14.17	11.60	3.34	36.01	4.35	46.92	7.69	43-57	3.91	1.95
299	298	285	9.44	8.08	3.12	38.66	3.45	42.76	6.57	48 52	1.51	1.94
385	299	----	12.16	10.25	3.41	33.30	5.29	51.61	8.70	39-61	4.55	----
325	303	----	12.34	8.52	2.56	30.12	4.40	51.67	6.96	37 63	1.56	----
267	309	224	11.73	7.36	2.57	34.92	3.56	48.46	6.13	42 58	1.23	2.00

206	313	226	12.83	8.85	3.04	34.07	4.32	48.83	7.33	41–59	1.52	2.20
205	313	212	12.83	7.18	2.60	36.26	3.01	42.01	5.61	46 54	1.57	1.98
300	314	276	10.06	8.95	3.41	38.41	3.63	40.74	7.04	48–52	1.91	
	314	165	10.48	13.71	5.17	37.70	6.38	16.58	11.55	45 55		1.89
101	319		12.53	11.40	1.23	28.80	7.39	51.35	11.62	36 61	2.78	2.26
386	331	231	12.18	9.53	3.08	32.3	4.94	51.85	8.02	39 61	1.51	1.61
272	350	321	13.06	7.15	1.98	27.81	3.79	53.05	5.77	34–66	1.38	2.01
Average	281	289	11.80	10.18	3.83	37.4	4.33	48.6	8.16	46 54	2.06	2.02

TABLE XI.—SHOWING CHEMICAL CHARACTERISTICS OF WHITE AUSTRALIAN WHEAT.

California number of sample.	Physical.		Chemical.										
				Calculated to dry matter.									
					Gluten.								
	Number kernels in 10 grams.	Relative hardness.	Moisture.	Total protein.	Gliadin.		Glutenin.		Total per cent of wheat.	Gliadin-glutenin ratio.	Non-gluten protein.	Ash.
					Per cent of wheat.	Per cent of total protein.	Per cent of wheat.	Per cent of total protein.				
152	216	395	13.10	9.43	4.02	42.61	3.897	41.31	7.91	50–49	1.516	---
162	228	---	13.08	10.27	3.394	33.03	5.315	51.73	8.71	38–61	1.565	---
161	231	---	13.10	10.01	3.095	30.92	5.351	53.45	8.45	36–63	1.565	---
160	236	---	13.03	9.44	2.83	29.96	5.05	53.47	7.88	36–64	1.56	---
26	237	434	12.07	13.42	4.63	34.49	7.02	52.29	11.65	40–60	1.77	2.16
67	240	401	12.11	11.41	4.45	38.98	5.42	47.48	9.87	45–55	1.54	2.28
73	249	375	11.51	9.83	4.10	41.72	3.81	38.74	7.91	52–48	1.92	1.90
382	255	---	12.21	7.35	2.13	29.10	3.68	50.16	5.81	36–64	1.54	---
127	256	232	11.50	8.27	3.11	37.56	3.63	43.85	6.74	46–54	1.53	1.98
605	256	443	12.41	10.83	3.72	34.35	5.56	51.32	9.28	40–60	1.55	---
129	259	240	11.45	9.18	3.47	37.76	4.18	45.51	7.65	45–55	1.53	2.08
68	260	362	12.59	11.02	4.84	43.87	4.63	42.01	9.47	51–49	1.55	2.13
66	261	396	12.63	9.86	4.20	42.57	4.10	41.65	8.30	51–49	1.56	2.12
23	264	111	11.49	12.06	6.49	53.74	2.73	22.66	9.22	70–30	2.84	2.06
62	267	248	11.57	11.43	4.83	42.23	4.49	39.27	9.32	52–48	2.11	2.17
153	268	410	12.39	10.10	3.29	32.54	5.26	52.09	8.55	38–62	1.55	2.20
311	268	323	11.20	8.36	2.87	34.32	3.90	46.57	6.77	42–58	1.59	2.05
398	269	---	12.18	8.16	2.56	31.38	4.05	49.65	6.61	39–61	1.54	---
231	272	381	12.18	7.72	2.45	31.71	3.92	50.74	6.37	38–62	1.35	1.92
381	272	---	12.27	9.54	3.13	32.85	4.86	50.90	7.99	39–61	1.55	---
304	274	327	8.88	10.15	3.24	31.89	4.98	49.08	8.22	39–61	1.93	1.99
320	277	---	12.09	9.89	2.99	30.23	5.36	54.14	8.35	36–64	1.54	---
383	279	346	12.68	9.77	3.47	35.43	4.62	47.19	8.09	43–57	1.68	1.82
134	280	172	12.15	9.90	3.95	39.88	4.41	45.51	8.36	47–53	1.54	---
288	281	365	14.75	9.63	3.27	34.00	3.94	47.99	6.73	41–59	2.12	2.13
232	288	289	12.54	6.92	2.37	34.16	3.19	46.04	5.56	43–57	1.36	1.93

69	293	278	12.73	13.36	6.3[illegible]	47.51	4.09	30.62	10.44	61–39	2.92	2.04
138	298	165	12.01	10.86	4.49	41.31	4.83	44.46	9.32	48–52	1.54	2.01
184	298	199	9.41	11.07	3.26	29.41	5.87	53.04	9.13	36–64	1.84	2.00
271	298		11.81	7.73	1.98	25.66	4.21	54.40	6.19	32–68	1.54	
322	299	324	14.36	8.54	3.35	39.21	3.61	42.21	6.96	48–52	1.58	2.09
28	300	355	12.35	9.27	4.37	47.18	1.85	19.93	6.22	70–30	3.05	1.96
275	302	241	12.56	7.79	2.87	36.81	3.56	45.60	6.43	45–55	1.36	1.86
22	306	355	12.52	13.21	6.74	51.03	3.32	25.09	10.06	63–37	3.15	1.93
141	316	171	9.90	13.00	5.02	38.23	6.60	50.17	11.62	43–59	1.48	1.90
326	326	293	12.50	10.48	2.91	27.81	6.01	57.36	8.92	33–67	1.56	1.53
23a	328	328	11.71	9.95	3.34	33.91	5.11	51.84	8.45	40–60	1.50	1.89
309	330	349	9.83	9.38	4.92	51.9	2.64	27.78	7.56	65–35	1.82	1.95
312	330	325	13.21	7.97	3.77	47.26	2.50	31.27	6.27	60–40	1.70	1.89
259	331		11.23	7.36	1.86	25.23	3.98	53.98	5.84	32–68	1.52	
78	337	240	11.54	11.07	4.47	40.30	4.88	44.08	9.35	48–52	1.72	2.01
77	342	264	11.41	10.53	4.28	40.62	4.14	39.34	8.42	51–49	2.11	2.21
251	357		12.54	9.67	2.56	26.48	5.56	57.21	8.12	32–68	1.55	
319	369	227	9.92	8.55	3.22	37.42	3.60	41.85	6.82	47–53	1.73	2.03
310	375	184	11.31	8.25	2.33	28.28	4.13	50.00	6.46	37–63	1.79	2.20
Average	286	305	11.75	9.81	3.44	35.1	4.39	45.1	7.83	46–54	1.98	2.01

TABLE XII.—SHOWING CHEMICAL CHARACTERISTICS OF LITTLE CLUB WHEAT.

California number of sample.	Physical. Number kernels in 10 grams.	Physical. Relative hardness.	Chemical. Moisture.	Chemical. Calculated to dry matter. Total protein.	Gliadin. Per cent of wheat.	Gliadin. Per cent of total protein.	Glutenin. Per cent of wheat.	Glutenin. Per cent of total protein.	Gluten. Total per cent of wheat.	Gliadin glutenin ratio.	Non-gluten protein.	Ash.
159	226	----------	11.28	13.64	4.94	36.14	7.19	52.64	12.13	41–59	1.51	1.83
143	236	----------	12.74	10.05	3.24	32.27	5.25	52.22	8.49	38–62	1.56	1.98
126	243	----------	12.96	8.58	2.81	32.80	4.21	49.00	7.02	40–60	1.56	2.17
146	243	----------	12.15	8.60	2.96	34.23	4.09	47.62	7.05	42–58	1.55	2.02
110	244	----------	12.31	9.27	2.95	31.86	4.77	51.42	7.72	38–62	1.55	2.03
139	247	----------	12.46	8.91	2.82	31.67	4.54	50.90	7.36	38–62	1.55	1.98
607	248	----------	12.32	8.07	2.71	33.62	3.81	47.18	6.52	42–58	1.55	----------
149	252	----------	11.98	8.95	2.81	31.35	4.60	51.40	7.41	38–62	1.54	2.07
145	255	----------	11.12	9.23	2.81	30.57	4.89	52.85	7.71	37–63	1.52	2.01
148	263	----------	12.45	9.55	2.95	30.82	5.06	52.93	8.01	37–63	1.54	2.07
124	271	244	11.43	9.08	3.60	39.62	3.95	43.48	7.55	48–52	1.53	1.96
138	271	----------	12.32	9.27	2.81	30.25	4.92	53.01	7.73	36–64	1.54	2.02
120	282	235	11.35	9.08	3.60	39.62	3.95	43.48	7.55	48–52	1.53	2.00
137	284	----------	12.41	8.36	2.56	30.60	4.25	50.82	6.81	38–62	1.55	2.04
144	285	----------	12.24	12.53	4.80	38.27	6.18	49.33	10.98	44–56	1.55	2.25
28a	286	242	11.69	9.02	3.34	37.20	4.10	45.42	7.44	45–55	1.58	1.94
142	289	----------	11.12	9.23	3.09	33.50	4.61	49.94	7.70	40–60	1.53	1.90
6	292	272	10.80	13.43	3.85	28.58	7.57	56.25	11.42	34–66	2.01	2.04
1	295	----------	11.56	10.10	4.30	42.55	3.62	35.83	7.92	54–46	2.18	2.22
141	306	186	11.91	8.58	2.43	28.97	3.91	45.50	6.34	38–62	2.24	2.12
139	311	211	13.08	9.26	2.72	29.32	4.65	50.19	7.37	35–65	1.89	1.98
128	315	227	11.40	8.18	3.15	32.96	3.50	42.76	6.65	47–53	1.53	2.10
51	316	77	12.07	8.10	2.76	32.88	4.29	50.21	7.05	39–61	1.53	1.90
51a	317	77	11.77	9.21	2.89	31.36	5.01	51.91	7.90	39–61	1.30	2.18
266	317	----------	12.48	7.38	2.55	34.52	3.51	47.52	6.06	42–58	1.32	1.98

12	327	----------	11.99	7.87	3.42	40.83	2.84	36.08	6.06	54-46	1.81	1.82
315	330	181	10.52	8.18	2.94	35.93	3.86	47.13	6.80	43-57	1.38	1.94
161	330	275	12.46	8.08	3.00	37.14	3.53	43.56	6.53	46-54	1.55	2.08
8	332	202	10.86	7.83	4.38	55.87	1.93	24.64	6.31	69-31	1.52	2.24
27	334	340	12.22	13.53	3.73	27.52	8.21	60.69	11.94	31-69	1.59	2.11
2	336	----------	11.48	11.60	5.14	44.30	2.80	24.15	7.94	65-35	3.66	1.95
53	336	281	12.81	8.76	3.43	39.13	3.84	43.85	7.27	47-53	1.49	2.28
143	337	198	11.80	9.03	2.86	131.62	4.18	46.30	7.04	41-58	1.99	1.97
145	340	----------	11.75	11.45	4.00	35.73	4.57	40.79	8.57	47-53	2.98	2.05
11	340	174	11.64	11.35	5.50	48.45	3.09	27.22	8.59	64-36	2.76	1.92
59	342	289	12.35	8.34	3.32	39.72	3.55	42.49	6.87	48-52	1.47	2.20
80	355	293	11.69	10.38	4.43	42.63	4.42	42.53	8.85	50-50	1.53	1.90
57	356	268	12.20	8.41	3.22	38.29	3.71	44.11	6.93	46-54	1.48	2.05
221	360	----------	12.01	8.59	2.70	31.48	4.34	50.53	7.04	38-62	1.55	----------
51	360	181	11.92	13.39	6.24	46.44	3.93	29.32	10.17	61-39	3.22	2.27
50	363	----------	12.16	8.61	4.13	48.01	2.52	29.23	6.65	62-38	1.96	2.11
56	363	256	12.64	10.13	4.11	40.56	4.33	42.71	8.44	49-51	1.69	1.99
49	363	122	12.44	9.19	3.55	38.63	1.53	16.65	5.08	70-30	4.11	2.17
50a	363	23	12.17	8.97	2.90	32.36	4.57	50.89	7.47	39-61	1.50	2.04
58	366	286	12.24	8.17	3.18	38.91	3.44	42.12	6.62	48-52	1.55	2.10
177	367	189	13.01	9.05	3.30	36.42	4.33	47.81	7.63	43-57	1.42	1.78
53	373	226	12.90	7.50	2.65	35.32	3.43	45.72	6.08	43-57	1.42	2.20
60	377	152	12.00	8.77	3.81	43.39	3.28	37.44	7.09	54-46	1.68	2.22
305	377	205	11.78	8.61	2.44	28.29	4.95	57.50	7.39	33-67	1.22	1.75
314	389	----------	12.02	10.06	3.41	33.90	5.10	50.74	8.51	40-60	1.55	----------
54	390	282	12.26	9.54	4.05	42.41	4.01	42.05	8.06	50-50	1.48	2.14
55	390	232	11.79	8.46	3.34	39.49	3.33	39.36	6.67	50-50	1.79	2.09
317	419	150	11.09	8.15	2.96	36.28	3.53	43.31	6.49	46-54	1.66	1.91
297	462	----------	11.65	8.74	3.26	37.31	3.94	45.08	7.20	45-55	1.54	----------
290	537	250	10.21	10.39	3.82	36.70	5.06	48.66	8.88	43-57	1.51	2.17
Average	324	214	12.01	9.35	3.43	36.68	4.23	45.24	7.66	45-55	1.69	2.04

TABLE XIII.—SHOWING CHEMICAL CHARACTERISTICS OF SONORA AND PROPO WHEATS.

Sonora.

California number of sample.	Physical.		Chemical.										
				Calculated to dry matter.									
					Gluten.								
					Gliadin.		Glutenin.						
	Number kernels in 10 grams.	Relative hardness.	Moisture.	Total protein.	Per cent of wheat.	Per cent of total protein.	Per cent of wheat.	Per cent of total protein.	Total per cent of wheat.	Gliadin-glutenin ratio.	Non-gluten protein.	Ash.
167	254	303	12.66	14.60	4.70	32.21	8.34	57.13	13.04	36–64	1.56	2.16
482	267	----------	12.67	9.49	3.14	33.17	4.78	50.42	7.92	40–60	1.51	----------
265	270	----------	12.88	7.59	2.27	29.91	3.76	49.55	6.03	38–62	1.56	----------
481	272	479	12.45	10.01	3.36	33.6	4.82	48.11	8.18	37–63	1.83	1.82
245	283	414	11.76	8.83	2.85	32.31	4.44	50.26	7.29	39–61	1.54	----------
228	296	----------	12.53	7.84	2.26	28.86	4.02	51.31	6.28	36–64	1.56	----------
74	296	370	11.84	9.77	4.07	41.64	3.77	38.63	7.84	52–48	1.93	2.01
269	332	----------	12.54	8.00	2.28	28.57	4.16	52.00	6.44	36–64	1.56	----------
76	337	408	11.38	9.08	3.46	38.13	4.08	44.97	7.54	46–54	1.54	2.11
33	356	422	12.88	8.76	3.66	41.75	3.08	35.21	6.74	54–46	2.02	1.95
63	359	303	12.16	15.80	7.53	47.62	5.87	37.18	13.40	56–44	2.40	1.82
252	371	----------	11.98	9.05	2.70	29.86	4.80	53.07	7.50	36–64	1.55	----------
246	371	----------	11.85	8.99	2.83	31.53	4.61	51.32	7.44	38–62	1.55	----------
249	371	372	12.05	9.33	3.21	34.47	4.70	50.43	7.91	40–60	1.42	1.89
140	444	203	12.20	12.11	4.55	37.45	4.35	40.73	8.90	48–52	3.21	2.20
137	457	186	10.31	7.80	3.64	46.71	2.64	33.85	6.28	58–42	1.52	1.97
257	518	221	12.34	8.03	2.58	32.24	2.93	36.51	5.51	56–44	2.52	1.98
Average	344	336	12.14	9.71	3.48	35.84	4.42	45.52	7.90	44–56	1.61	1.99

Propo.

16	236	374	11.96	10.50	4.53	42.76	3.74	35.37	8.27	55–45	2.23	2.05
387	263	----------	10.30	8.97	3.31	36.89	4.15	46.21	7.46	44–56	1.51	1.85
15	270	289	12.00	9.96	3.89	39.09	4.45	44.70	8.34	47–53	1.62	2.05
111	291	----------	9.88	9.07	3.55	35.28	4.51	49.61	8.06	42–58	1.01	1.91
17	322	311	11.90	11.94	5.39	45.15	3.84	36.5	9.23	55–45	2.71	1.94
79	341	260	11.90	11.76	4.84	42.23	5.08	44.31	9.92	49–51	1.84	2.17
Average	287	308	11.32	10.37	4.25	40.23	4.30	42.78	8.55	50–50	1.82	2.00

TABLE XIV.—GENERAL AVERAGE.

Variety.	Physical.		Chemical.										
				Calculated to dry matter.									
					Gluten.								
					Gliadin.		Glutenin.						
	Number of samples represented.	Number kernels in 10 grams.	Moisture.	Total protein.	Per cent of wheat.	Per cent of total protein. Gliadin number.	Per cent of wheat.	Per cent of total protein.	Total per cent of wheat.	Gliadin-glutenin ratio.	protein. Non gluten	Ash.
White Australian	42	280	12.05	9.89	3.74	37.81	4.39	44.39	8.13	46–54	1.76	2.01
Bluestem	33	281	11.80	10.18	3.83	37.40	4.33	48.60	8.16	46–54	2.06	2.02
Little Club	52	324	12.01	9.35	3.43	36.68	4.23	45.24	7.66	45–55	1.69	2.04
Sonora	17	344	12.14	9.71	3.48	35.84	4.42	45.52	7.90	44–56	1.61	1.99
Propo	5	280	11.53	10.64	4.44	40.90	4.32	42.09	8.76	49–51	1.88	2.02
Grand average	149	298	12.11	9.95	3.78	37.7	4.34	45.2	8.29	46–54	1.66	2.01

The first thing which is apparent from this table of averages is the much larger moisture content for these wheats than is usually stated for wheats. In fact the variety tables show quite a range in moisture, all the way from a maximum of 14.17 in No. 391 to 9.18 per cent. in No. 196, with a general average for all samples of 12.11 per cent. This is a considerably higher figure than it was expected to find, especially as the analyses for the most part were made during the dry season. Richardson, as an average of 310 samples of American grown wheats, gives 10.50, and in these samples there is also a wide difference between individual samples, viz., from 7.1 per cent. to 14 per cent.

In the case of results here stated wherever there seemed to be any question, the work was checked by a duplicate determination. This generally high moisture content of the samples may perhaps be partially explained from the fact that the laboratory is situated comparatively near the bay and the atmosphere is usually quite moisture-laden even during the summer. That grain absorbs moisture from the air very readily, has been shown by experiments carried on at this Station in bringing grain from the interior sections of the State where the atmosphere is very dry to the coast region. Undoubtedly this fact has had much to do with producing the condition here shown.

It is claimed that the moisture that wheat will thus absorb during a voyage from San Francisco to Liverpool will sometimes increase its weight enough to pay the entire cost of freight (?). In the experiments above indicated it was shown by Dr. Hilgard that wheat from the inland portions of the State might increase as much as 25 per cent. by absorption of moisture, while a gain of 5 to 15 per cent. may be looked for with absolute certainty. A difference of 9 per cent. was observed in twenty-four hours. *It is barely possible that this* increased moisture content may have some chemical influence upon the quality of the gluten which is a matter that will be again touched upon.

As to protein content the varieties stand in the following order, Propo, Bluestem, Australian, Sonora, and Little Club. This is the more noteworthy since it is in the same order that the miller would probably class these wheats. Thus it seems that a determination of the total protein, or what amounts to the same thing, the total nitrogen, would serve to classify the varieties in a very general manner as to adaptability for milling, aside from their physical characteristics.

In 310 analyses of American wheats compiled to 1890, the protein content (N x 6.25) varied from 8.1 to 17.2, with an average of 11.9 per cent. in samples carrying 10.5 per cent. average moisture content, which calculated to the same basis of dry matter and factor as presented in

these wheats would correspond to an average of 12.08 per cent. The analyses here shown give an average protein content of the white wheats of 9.95 per cent. in the dry matter, or about 2 per cent. lower than the general average of the common wheats of the country.

The gliadin follows the same order as the total protein. The glutenin, however, does not follow the reverse order, without a variation in the order of arrangement in the wheats, owing to a variation of the non-gluten proteids. It will be seen that in the matter of non-gluten proteids Bluestem exceeds the others quite materially. The effect of this is to reduce the glutenin, and thus to displace this variety from the order shown by the total protein. The gluten, chemically determined, runs in the same direction as the total protein, which would necessarily follow unless the non-gluten proteids were unduly large and the difference in gluten between any two varieties very small.

Another thing which appears from the table is that as between varieties neither the total protein nor the gliadin bear any definite relation to the size of the kernels.

Turning attention to the proportion of total protein of wheats existing in the form of gluten, as determined chemically, we find as follows:

Bluestem	80.2 per cent.
White Australian	82.9 per cent.
Little Club	81.9 per cent.
Sonora	81.4 per cent.
Propo	82.3 per cent.
Average	8.15 per cent.

There is shown to be very little difference in the ash content of the varieties. It is seen that the ash does not follow the size of the kernel closely, as it does in the north central states, nor is there as large a percentage. In a general way it follows within the type, but the particular character of the wheat not within the same type breaks the order in this regard. Thus a Sonora sample, with its thin bran, which part contains the larger portion of ash, carries a considerably lower per cent than does a Bluestem sample with the same size grains. As compared with the average ash content of the United States wheats, the California grown varieties are relatively low.

It is the custom to consider both the gliadin-glutenin ratio and the gliadin number in connection with flours rather than the whole wheats, because the operation of milling changes the relation of the ingredients to a greater or less extent, but since it is highly desirable for us to make certain comparisons of grain before more than a very few plants can be had, and since, further, it was desired to ascertain what was the result

of milling upon this ratio in the case of the common white wheats, these data are also calculated for the whole berry, as well as for the flour later. To either the miller or baker it will have its greatest significance in connection with the flour.

Since the larger part of the gliadin is in the endosperm of the grain the milling will of course raise the gliadin number of the flour above that of the whole wheat.

While Table XIV shows an appreciable difference between one variety and another, within the same variety there is even a greater difference between individual samples than between the several varieties, as will be seen by referring to the minimum, maximum, and average results, as subjoined:

	Maximum protein.	Minimum protein.	Average protein.
Bluestem	14.40	7.15	10.18
White Australian	13.42	6.92	9.89
Little Club	13.53	7.38	9.35
Sonora	15.80	7.59	9.71
Propo	11.94	8.97	10.64

Australian, for instance, shows a range of from 6.92 per cent. of total protein in the dry matter of No. 232 to 13.42 per cent. in No. 26.

Very generally speaking the gliadin seems to rise and fall with the total protein, but there seems to be no definite or absolute ratio between the two. This is also in accord with most other results that have been published. There are exceptions even to this statement that the gliadin rises and falls with the total protein in whole wheat; as witness, samples 326 and 312, the former carrying 10.48 per cent. total protein and 2.91 per cent. gliadin, and the latter showing but 7.97 per cent. total protein but rising in gliadin content to 3.77 per cent. Still, while individual instances of this kind do occur, it may be said that in general the gliadin does follow the trend of the total protein but does not bear any definite ratio to it.

The same statements hold concerning the other varieties, although Bluestem appears to run more even than White Australian. Little Club, while generally running lower in protein, has certain lots which rank very high in this group of compounds, as for instance Nos. 459, 444, 6, 27, and 29, *which suggests that it might be possible to fix these characteristics to a certain extent at least*, even in this variety. The

unreliability of this variety in its present condition, however, has given it a very low standing among millers.

These cases of unusually high protein content are also apparent in the other varieties. The underlying causes of such wide variation are not apparent as yet. One would at first, perhaps, assume that it was due to soil conditions of the locality, but an examination of the record accompanying each sample does not reveal anything definite in this direction.

In this connection it is interesting to record a series of analyses of grain taken from the entire product of individual plants. Each of the samples used for the analyses stated below were made up by using the grain from one half of each head of an individual plant. Even here, in the case of the three varieties cited, there will be noted the great variation between individual plants, and these were grown under exactly the same climate and as near as possible upon the same character of soil. The variation in individual plants of Australian ranges from a minimum of 9.06 to 15.31 per cent. total protein, or a variation of 6.25 per cent. within 25 plants, and the range in Little Club is even greater, being from 7.12 to 16.22. Such a variation as here appears among individual plants, grown under the same conditions of soil and climate, would seem to cast grave doubt as to the effect of climate or soil upon the composition of the grain, except in a very general manner, and to throw the ultimate causes of difference within the plant itself.

TABLE XV.—SHOWING CERTAIN VARIATIONS BETWEEN INDIVIDUAL PLANTS OF WHEAT.

Club—California No. 459.					Australian—California 452.					Propo.				
Centgener number.	Number kernels in plant.	Weight of kernels per plant (grams).	Per cent nitrogen in kernels.	Per cent total protein.	Centgener number.	Number kernels in plant.	Weight of kernels per plant (grams).	Per cent nitrogen in kernels.	Per cent total protein.	Centgener number.	Number kernels in plant.	Weight of kernels per plant (grams).	Per cent nitrogen in kernels.	Per cent total protein.
4718	219	10.241	1.714	9.74	4813	103	3.7808	2.182	12.39	7317	144	7.0617	1.793	10.18
4704	244	10.538	2.614	14.85	4818	119	5.0306	1.835	10.42	7315	150	7.2607	1.864	10.59
4711	244	10.451	2.646	15.03	4821	121	5.0302	2.345	13.32	7316	150	5.9803	2.078	11.80
4722	246	11.143	1.279	7.26	4810	123	4.9826	1.740	9.88	7302	168	8.8266	1.944	11.04
4723	254	11.254	2.031	11.54	4809	128	5.1400	1.954	11.10	7310	173	8.1147	1.786	10.14
4701	263	12.480	2.232	12.68	4816	128	5.8740	1.732	9.84	7318	173	9.2274	1.852	10.52
4721	264	9.397	2.758	15.67	4814	135	5.5290	1.752	9.95	7320	199	9.5840	1.776	10.09
4707	266	11.797	2.359	13.40	4819	139	5.9616	1.609	9.14	7311	200	7.7578	1.855	10.54
4724	270	12.176	2.473	14.05	4820	144	6.1408	2.459	13.97	7303	210	10.7348	1.419	8.06
4702	272	12.480	2.232	12.74	4817	150	5.2002	2.002	11.47	7308	218	10.5668	1.547	8.79
4720	278	11.401	1.866	10.60	4823	151	5.6950	1.321	7.50	7314	219	11.4692	1.725	9.80
4716	281	13.061	1.889	10.73	4808	152	6.4767	1.794	10.19	7309	229	12.5288	1.779	10.10
4709	290	12.004	1.824	10.36	4806	155	6.9606	1.595	9.06	7312	245	10.7326	1.954	11.10
4713	294	12.054	1.907	10.59	4822	157	6.6148	2.696	15.31	7321	261	12.9620	2.415	13.72
4719	295	11.897	1.476	8.38	4811	159	6.3916	2.417	13.73	7313	284	12.1798	2.499	14.19
4705	296	12.274	2.614	9.03	4824	166	5.9324	2.109	11.98	7307	306	13.173	2.362	13.45
4712	299	13.104	2.485	14.12	4812	176	8.2980	1.722	9.78	7319	325	13.9718	2.312	13.13
4717	303	12.536	1.597	9.07	4807	182	8.6880	2.069	11.75	7306	338	13.0815	1.629	9.25
4715	304	13.003	1.995	11.33	4805	187	8.5149	1.830	10.39	7304	0	8.9246	1.946	11.05
4710	325	13.825	1.931	10.97	4815	196	8.9176	1.928	10.95	7305	0	7.7959	1.821	10.34
4708	347	13.850	2.141	12.16	4825	203	7.1600	1.979	11.24					
4714	376	18.074	2.010	11.42	4803	206	6.7236	2.133	12.12					
4706	412	17.819	2.856	16.22	4804	206	9.5090	1.770	10.05					
4703	539	24.388	1.254	7.12	4802	232	7.5580	1.713	9.73					
4725	555	24.672	1.432	8.13	4801	257	1.9516	1.704	9.68					
Average	309	13.433	2.064	11.49	Average	163	6.7224	1.936	11.00	Average	244	10.0967	1.9178	10.89

The effect of seasonal differences in the grain would require a series of analyses covering a longer period than is here represented, but it is generally regarded that these do have a greater or less effect in causing a fluctuation of the entire mass for any one season as compared with another. Below are presented averages of the previously stated analyses separated according to the years in which they were grown.

TABLE XVI.—AVERAGE COMPOSITION AS AFFECTED BY SEASON.

	Australian.		Club.		Bluestem.	
	1904.	1905.	1904.	1905.	1904.	1905.
Number kernels in 10 grams	287	283	342	297	281	280
Relative hardness of kernel	286	327	212	222	249	328
Moisture	11.71	12.42	11.86	12.13	11.81	11.62
Total protein	10.38	8.90	9.43	9.36	10.47	9.12
Gliadin	3.95	3.19	3.59	3.13	4.05	3.00
Glutenin	4.58	4.08	3.96	4.71	4.23	4.70
Gluten	8.53	7.27	7.55	7.84	8.28	7.70
Non-gluten protein	1.85	1.63	1.88	1.52	2.18	1.41
Carbohydrates and fat	87.42	89.08	88.58	88.72	87.47	88.93
Ash	2.00	2.02	1.99	1.92	2.06	1.95

It appears from these averages that the season of 1904 had a tendency to produce a smaller kernel, and one of somewhat higher total protein than did the season of 1905, and that this was also true so far as the gliadin was concerned, but that it does not hold with reference to true gluten.

It is undoubtedly true that should the season be such as to seriously arrest the development of the grain, and thus produce a pinched kernel, then it results in a markedly higher gluten as well as gliadin content. This is shown in the analyses of a considerable number (82) of pinched wheat samples grown in the same years as the samples given above, the results of which analyses are stated in Table XVII.

TABLE XVII.—SHOWING AVERAGE COMPOSITION OF PINCHED WHITE WHEATS.

Name.	Kernels in 10 grams.	Chemical analysis.								
		Moisture.	Calculated to dry matter.							
			Gluten.					Total per cent of wheat.	Non-gluten protein.	Ash.
			Total protein.	Gliadin.		Glutenin.				
				Per cent wheat.	Per cent total protein.	Per cent wheat.	Per cent total protein.			
Club (46)	405	12.28	9.79	3.88	39.63	4.33	44.23	8.21	1.56	2.11
Australian (17)	341	11.59	11.78	4.83	41.00	4.95	42.02	9.78	2.00	2.12
Bluestem (13)	366	12.18	10.60	3.85	35.27	4.96	47.84	8.81	1.97	2.02
Sonora (6)	442	12.12	9.62	3.68	38.23	3.76	39.08	7.44	2.18	2.08
Average (82)	388	12.04	10.45	4.06	38.5	4.50	43.8	8.56	1.89	2.08

MILLING TESTS.

The flour used in making our ordinary bread is the white portion called the endosperm separated from the remainder of the kernel. The whole aim of the miller is to get as large a portion of this white material free from the dust hairs and small particles of bran (cuticle, episperm, tegumen (?) and embryonic membrane taken together), and other undesirable products which impair the color, odor or quality of the flour.

To-day there are probably more differences in mills and methods of milling than ever. To mill all the different kinds of wheat and mill them to the best advantage into the different products for which each wheat is best adapted, slightly different processes must be employed, and millers do not agree as to the best method for obtaining certain ends, nor do they seem to think it urgent that a standard by which they mill should be adopted. Some agitation has been started, however, and it is hoped that some satisfactory standard may be found. As the situation now stands, every miller makes his own standard and determines the quality of his brand, and to the purchaser the name is meaningless.

As stated above, the aim of the miller is to obtain the largest possible yield of clear white flour. This is accomplished by screening, scouring, fanning, and washing the wheat, as may be deemed necessary, before grinding it. Washing is very necessary with California grown wheats since they are not as clean as eastern grown ones. Then, too, the native wheat is harvested and immediately bagged, in which condition it stays until it reaches the mill. Not only do they contain the dry dust from the dry summer fields, but also smut and bunt as well as a goodly supply of grasshopper segments; and the aroma, after two, three or more months, penetrates the seed to such an extent that it is noticeable for some time after it is emptied from the bags. Eastern dealers in grain rarely, if ever, find this condition, but instead have "musty grain" which is caused by dampness. Aeration greatly improves musty wheats, and the same process would improve the above-stated condition in California.

Having cleaned the wheat properly, it is put through a series of two to six corrugated rolls and five to eight sets of smooth rolls, the number of each varying with the process used. Between each set of rolls the middlings are sized and separated into a varying number of streams, so that every set of rolls furnishes a stream to every following set as well as some portion of finished product. The total number of streams produced depends entirely upon the method of sifting and bolting.

The corrugated rolls are primarily for loosening dust, hairs, and the outer portion of bran layer. No attempt is made at grinding, but only at cracking. In this process some of the particles of flour are lost, and this, with the dust and other loose particles, constitutes the low-grade flours. The amounts lost in this operation depend upon the condition and quality of wheat and also upon the skill of the miller.

After the removal of the low-grade flour and the bran portion, the remainder of the process is the purification and reduction of the middlings into the higher grades of flour. Since the portion near the bran has a higher per cent. of gluten than the center of the grain, it is obvious that, for a flour with high gluten content, the milling must be as complete as possible and since the central portion is the first to be reduced because it is softer, and unprotected after the grain is split, the flour from the first breaks contains less gluten than that from later reductions. While the product from the last rolls is richest in total protein, it is also contaminated with particles of bran and a small amount of germ, which lower the color and quality of the flour so it can not be included in the patent grades, but rather in the clear or bakers' grade.

Method Pursued.—The preparation of the flour was made on a small experimental mill with two sets of rolls, one with medium corrugations and the other smooth. The sifting was done in an attached frame carrying three separate bolting cloths or wire sieves, as was necessary. This frame was completely enclosed, and the pan for receiving the flour was boxed under the platform, the flour being conducted from the shaker through an opening in the platform into the pan by a canvas stocking so as to reduce the loss from dusting to a minimum.

BRAN, SHORTS, AND FLOUR.

The terms flour, shorts, and bran are rather flexible terms, and hardly capable of exact definition, and for this reason many regard the stated yield of flour as having relatively small value, yet, where the tests are made with some degree of uniformity, the mill not being forced, and only that portion of the possible flour being put into the "straight" product, which can be so done without reducing the color standard, it should convey a meaning of relative value. It is, of course, perfectly easy to make seventy per cent. or more of straight flour from even the lowest grades of wheat, provided the term be employed in a sufficiently broad sense to include all that can be obtained from the wheat, and a little more grinding will always bring a little more of the bran into the shorts. For the above reasons the proportions of products obtained by different operators may seem to vary quite widely, and the same variation occurs in the commercial products, particularly in what is commonly called "patent flour," which is largely dependent upon the flexibility of the manufacturer's conscience.

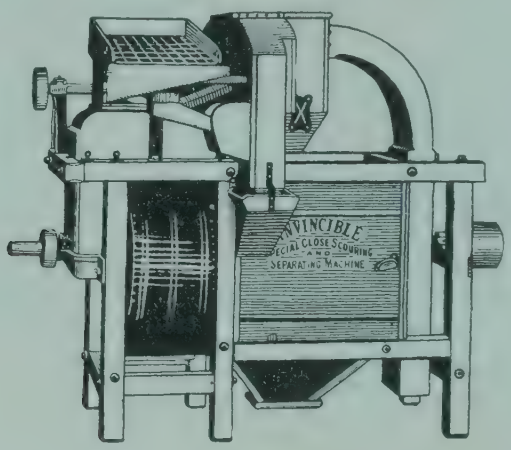


FIG. 14.—Showing small grain scourer used in these experiments.

In these experiments, before grinding, the samples were cleaned as thoroughly as possible by screening and passing them through a small sized "Invincible" scourer designed to remove all dust particles and the brush upon the ends of the kernels. The varieties all being "soft" wheat, it was not deemed necessary to "temper" them with water, as is frequently done. Ordinarily, the grain was subjected to two reductions upon the corrugated rolls, although in a few cases a third was deemed necessary. The middlings were usually reduced in three operations, more were required in a few instances.

Flour.—Since only a "straight grade" flour could be made, the material was all passed through a No. 10 bolting silk, and care was taken to include in this all the material which seemed by its color to be fit for the making of fair quality of bread. To unify the product it

was now passed through a No. 11 bolting silk, and all that passed this silk was termed *flour*. The part retained on this gauze, when judged to be clean, was termed "low grade." The flour from the first break was not dark enough to be necessarily put into the low grade class.

Bran.—The portion of the chop retained on a 2 mm. mesh wire sieve was termed "bran."

Shorts.—The "shorts" was separated from the middlings by a No. 50 and a No. 70 grit gauze, the former being used in the first and the latter in the last two separations.

In each case a kilogram was taken as the basis for milling. The yield of mill products is stated in the subjoined table, which also states the bushel weight, the condition of the berry, and the relative "commercial

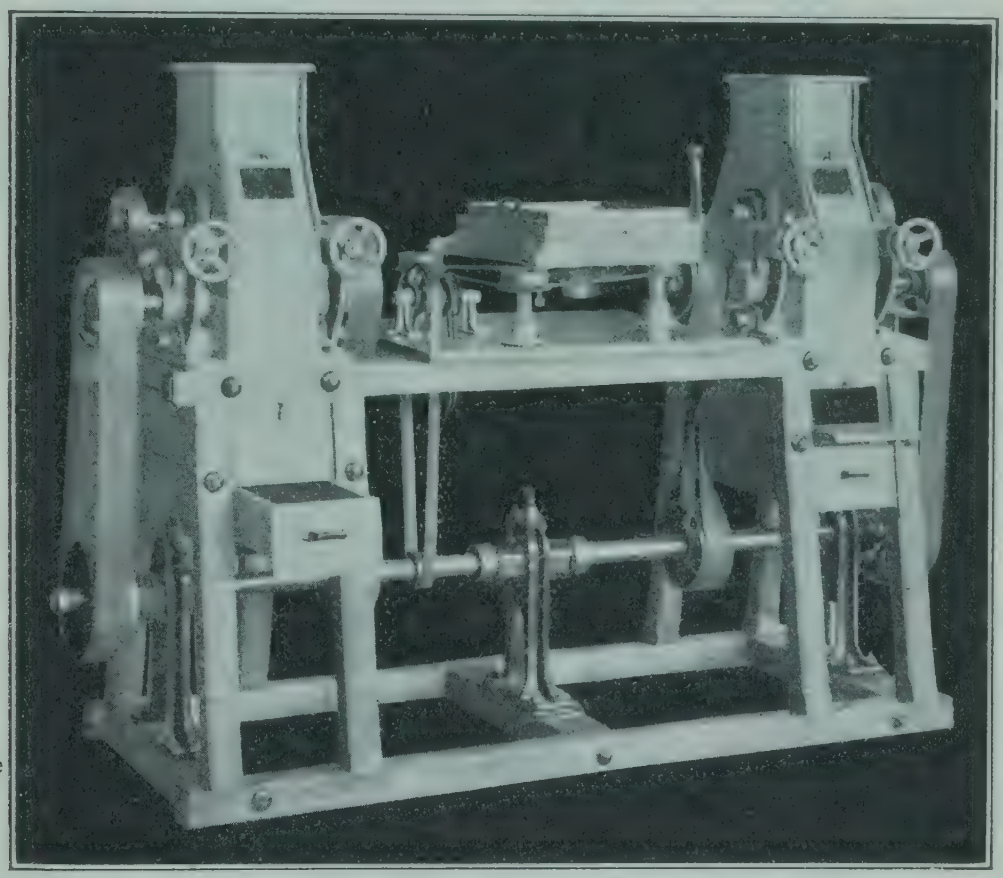


FIG. 15.—Small Allis-Chalmers mill used in these experiments.

grading," which latter was obtained by taking the average of the grades placed upon the samples by the "official" grain inspector of the Merchants' Exchange and that of one of the well known millers of the State, on the basis of the terms "choice milling," "good milling," "fair milling," and "poor milling," and allowing a difference between each term of 2.5 points, choice milling being rated as 100. The loss due to dusting and arising from transfers of material ranging from zero to three per cent., is likely to belong mostly to the flour and for the sake of uniformity has been so returned (?).

Not much difference could be noticed in the reduction of the various samples. The relative hardness of some could easily be recognized, especially if two samples with extremes of hardness were ground one after the other. There was an appreciable difference in the bolting of the same. Some of the Club samples, as millers generally recognize, required more time to obtain the same separation, but some also bolted as readily as either Bluestem or Australian.

TABLE XVIII.—YIELD OF MILL PRODUCTS.

White Australian.

Laboratory number.	Bushel weight, pounds.	Condition of berry.	Relative grading.	Bran, per cent.	Shorts, per cent.	Flour.		Loss.
						Straight.	Low grade.	
231	63.0	Plump	100.0	18.0	11.5	69.0	2.0	.5
288	62.5	Plump	100.0	18.0	9.5	70.5	2.0	.5
304	62.5	Plump	100.0	16.0	14.0	68.0	2.0	.0
311	61.0	Plump	100.0	16.5	13.5	68.0	2.0	2.0
184	60.5	Sl. pinched	100.0	16.5	12.9	68.7	1.9	.8
23a	61.0	Plump	100.0	16.5	11.0	70.0	2.0	2.0
322	60.5	Plump	100.0	15.5	12.0	70.5	2.0	.5
326	61.0	Plump	100.0	17.0	12.5	68.5	2.0	1.0
232	59.5	Plump	100.0	17.0	12.5	69.0	1.5	.0
383	62.0	Plump	98.7	18.0	12.0	68.0	2.0	1.5
62a	58.9	Plump	98.7	15.5	12.5	70.0	2.0	1.0
319	59.5	Plump	97.5	16.0	13.0	68.5	2.5	.5
309	59.5	Plump	97.5	16.0	13.5	68.5	2.0	.5
41a	56.1	Pinched	97.5	15.5	16.5	66.0	2.0	1.0
310	58.0	Plump	96.7	16.0	14.5	67.5	2.0	1.0
312	58.0	Plump	96.7	18.0	11.5	68.5	2.0	1.0
35	57.5	Pinched	96.7	16.5	13.5	68.5	1.5	1.0
275	59.0	Plump	92.5	16.0	13.5	68.0	2.0	.0
	63.0	Maximum	100.0	18.0	16.5	70.5	2.5	2.0
	56.1	Minimum	92.5	15.5	9.5	66.0	1.5	.0
	60.0	Average	0.0	16.6	12.8	68.7	1.9	.9

Washington Bluestem.

303	62.0	Plump	100.0	16.5	10.5	70.5	2.5	2.5
17	61.0	Plump	100.0	17.0	12.0	69.0	2.0	3.0
268	60.0	Plump	100.0	16.0	12.0	70.5	1.5	.5
205	60.7	Plump	98.7	19.0	9.0	70.0	2.0	.0
299	59.0	Sl. pinched	98.7	16.5	13.0	68.5	2.0	.5
262	60.0	Pinched	98.7	15.5	13.5	69.0	2.0	.5
19a	59.0	Sl. pinched	98.7	15.5	14.0	67.5	2.0	.5
15a	59.3	Plump	98.7	16.0	14.5	67.5	2.0	3.5
272	59.5	Sl. pinched	98.7	17.0	11.5	69.5	2.0	.5
212	60.0	Sl. pinched	97.5	16.0	12.0	70.0	2.0	2.0
267	59.5	Sl. pinched	97.5	15.0	13.0	70.0	2.0	.0
10a	58.5	Plump	97.5	16.5	12.5	69.0	2.0	.5
386	58.8	Plump	96.7	18.0	13.0	66.5	2.5	1.5
302	58.0	M. pinched	95.0	17.5	13.5	67.0	2.0	.5
206	58.0	Sl. pinched	93.7	19.0	15.0	64.0	2.0	2.0
208	57.2	M. pinched	90.0	17.0	14.0	67.0	2.0	2.0
300	56.5	Plump	93.7	18.0	13.0	67.0	2.0	1.0
	62.0	Maximum	100.0	19.0	14.5	70.5	2.5	3.5
	56.5	Minimum	90.0	15.0	9.0	64.0	1.5	.0
	59.3	Average	0.0	16.8	12.7	68.5	2.0	1.3

Little Club.

Laboratory number.	Bushel weight, pounds.	Condition of berry.	Relative grading.	Bran, per cent.	Shorts, per cent.	Flour.		Loss.
						Straight.	Low grade.	
163	60.5	Sl. pinched	97.5	15.0	14.5	68.0	2.0	2.5
233	61.7	Pinched	97.5	16.5	14.0	67.5	2.0	1.5
266	60.0	Plump	96.7	16.5	12.0	69.5	2.0	.0
253	59.0	Plump	96.7	18.0	12.5	67.5	2.0	.0
28a	57.5	Plump	96.7	14.5	13.5	70.5	1.5	1.5
313	58.0	Sl. pinched	95.0	17.0	12.0	69.0	2.0	.5
179	60.2	Sl. pinched	95.0	17.0	14.5	66.5	2.0	2.5
51a	58.5	Sl. pinched	95.0	16.0	14.0	68.5	1.5	1.0
185	60.0	Sl. pinched	93.7	16.0	15.0	66.5	2.5	.5
317	59.4	Plump	93.7	16.5	12.0	70.0	1.5	1.0
277	57.5	Plump	93.7	15.0	14.5	67.5	3.0	1.5
305	59.5	Plump	93.7	17.0	13.0	68.0	2.0	.5
169	60.0	M. pinched	93.7	18.0	14.0	66.5	1.5	.0
50a	58.5	Plump	93.7	16.0	12.5	69.5	2.0	.0
315	59.0	Plump	92.5	17.0	13.0	68.0	2.0	.5
270	54.5	Pinched	92.3	18.0	12.0	69.0	1.5	1.0
247	54.0	Sl. pinched	92.5	19.0	14.0	65.5	1.5	.0
290	57.8	Sl. pinched	92.5	17.5	14.0	67.0	1.5	2.5
316	55.0	Pinched	90.0	17.0	11.5	69.5	2.0	.5

Sonora.

481	66.0	Plump	100.0	11.0	20.0	66.0	3.0	2.0
254	63.7	Plump	98.7	16.0	13.0	69.0	2.0	1.0
174	63.0	Plump	97.5	9.0	20.5	68.5	2.0	2.5
249	62.8	Plump	97.5	15.5	14.0	68.5	2.0	1.5
257	58.7	Plump	96.2	16.0	16.5	65.0	2.5	2.5
248	59.0	Sl. pinched	85.0	19.0	14.0	65.0	2.0	1.0

Propo.

468	62.8	Plump	100.0	16.0	12.5	69.0	2.5	2.5
225	57.0	Sl. pinched	95.0	11.0	23.0	64.0	2.0	.5
226	53.0	Pinched	90.0	15.5	20.0	61.5	3.0	1.5

Examining the columns recording the flour yield, there appears but small difference in the flour yielding power of the three principal wheats, with the White Australian in the lead, the average yield being 68.7 per cent. for the White Australian, 68.5 per cent. for the Bluestem, 68.2 per cent. for the Club, and 67.0 per cent. for the small-grained Sonora.

The greatest difference in flour yield is seen to be 8 per cent. This occurs between samples No. 206, which yielded only 62 per cent. and several samples each yielding 70 per cent. Number 206 is a fairly plump sample, but the kernels are not dense and the weight per bushel is only 58 pounds, while those samples which yielded 70 per cent. flour averaged about 61 pounds per bushel. It does not follow, however, as may be inferred, that those wheats weighing heaviest invariably yield the largest amount of flour.

In the yields of bran and shorts, the average amount obtained is about 30 per cent. of the whole wheat. The Sonora wheat, on account

of its smaller size, giving a larger proportion of surface, yields a larger percentage amount of these constituents. The bran coat is actually thinner on this type than on the other three, so that if the kernels were as large as those or Bluestem it would undoubtedly give larger flour yields.

THE BAKING VALUE OF A FLOUR.

In deciding upon the baking value of a flour there are three points which demand particular consideration, viz., the color, the gluten content, and the strength, or absorption capacity, all of which points must be satisfactory in a flour of the best quality for baking. A chemical analysis alone of a flour tells very little of direct value to a baker, as it does not necessarily indicate the character of the loaf which that flour will produce, but if the baker knows the gluten content, the strength, and the color, he can form a fairly accurate idea as to how the flour will act in baking. In addition to the above, there are certain other characteristics which act as aids in enabling one to have a better understanding of a flour. In general, it may be said that there are two classes of flours as to their effect upon the touch. One type may be described as granular, hard, or lively. It may be poured from one vessel to another with comparative ease, and is somewhat suggestive of an extremely fine sand. The other type is usually referred to in contradistinction as soft, velvety, or smooth. It is this latter type that is obtained from the milling of the soft white wheats here under discussion. Relatively speaking, the latter type is considered weaker than the former in bread value, but better adapted to pastry, biscuits, etc. This, however, is not without frequent exception, as very often soft wheat flours may be found to have excellent baking value even when made without blending, as will be seen in the tabulation later.

Color.—One of the most important characteristics of a good flour is its color. While mere color is of no direct benefit, it is a property much desired, and one by which the relative merits of flours are judged to a large extent by millers, brokers, and housewives alike. The color depends largely upon the mechanical composition of the flour. The poorer the process of milling the larger the amount of foreign particles which give a darker color. High moisture usually has a darkening effect. The color of the gluten is also effective in varying the color of the flour.

California wheat produces a very white flour on account of it being very starchy and having a small amount of gluten, which is not so highly colored as in other wheat flours. They have little of that creamy color so characteristic of eastern flours. There are some, however, that are quite as yellow, and in the Sonora flours examined some had considerably more yellow tint than the eastern flour used for a standard of comparison.

In the washed glutens the color is more noticeably variable than in the flour. For the most part these glutens are blue gray. Occasionally there is a creamy one; generally the creamy-colored flour gives a creamy gluten, but a creamy-colored gluten need not follow from a creamy flour. The Sonoras invariably yielded creamy glutens. The whitest flours do not necessarily produce the whitest loaves. In no case does the color of the bread hold the same relative position in the loaves as the color of the flour. In a general way, all tinted flours are a little darker relatively when baked, as their color value does not increase. The yellow-tinted flours appear to change their relative value more markedly.

The color, however, has no real relation to the baking or nutritive value, and, as may be inferred from what has been said, is not a very reliable guide as to the color of the resulting loaf, although it generally holds that gray flour produces a dirty-colored loaf, and that, inasmuch as a yellow flour usually indicates a high gluten content, they usually show less loss in the oven and therefore have a better bread value, and do not necessarily produce a darker loaf.

The matter of color, while it certainly does affect the commercial value of a flour, is a decidedly sentimental factor. It is also noticed that those flours which enhance their color value in the process of baking show a slightly lower loss in the oven. A high color value is quite commonly associated with low gluten and low strength.

The amount and quality of gluten also have their effect on the color of the bread. Those flours with a low quality of gluten, and especially if the gluten is rather dark, produce bread that appears uneven in color. This is due to the breaking and massing of the gluten, thereby making uniform distribution of the gases impossible, and preventing uniformity in color.

In carrying this comparison to the dough, it is seen that the same relation invariably holds. The color value of flours from this class of wheats is high both in the dough and in the flour. The relative color value between the flour and the dough made from it is not expressed in the table, because of the lack of a satisfactory method of definite statement of this factor, but the dough is always relatively darker than the flour from which it is made.

As to the relative color of the breads, it is the same as in the dough and flour with the exception that the yellow Sonora flour has baked whiter than the Club flour, which is probably another reason why millers do not like Club wheats.

On account of lack of time and the somewhat mixed conditions of these commercial wheats, no attempt was made to subject them all to either milling or baking tests, but instead selections were made to represent as wide a range of condition as possible. Owing then to the com-

paratively small number of samples baked, no attempt will be made to formulate definite statements to be applied to the several varieties when the samples are pure. This must come from a later study now in progress in which the varieties are of known purity. An inspection of the table, however, shows a number of interesting points which will next be discussed.

Inasmuch as the calculation to dry matter would not change the relative position of the samples in any case, the results are stated on the basis of the original condition of the material.

Moisture.—As in the case of wheat, the moisture content of flour is largely determined by the atmospheric conditions under which it is stored. Around the bay sections of the State, flours would show a much larger percentage of moisture than would those of the same grade in the interior, and likewise their absorption capacity, or strength, would be somewhat lessened, provided the gluten content remains the same. From a commercial standpoint the question of moisture is as important in the case of flour as in that of wheats mentioned earlier in this bulletin. A large profit it undoubtedly brought to dealers through the influence of this factor alone.

As might be expected, the moisture content of the flour is invariably higher than that of its corresponding wheat.

The maximum moisture content shown in any of these flours was 14.13 per cent. and the minimum 11.32 per cent., with a general average of 13.57 per cent. for all the flours examined. These are very high figures as compared with those from Canadian flours, which are reported as carrying from 9 to 10 per cent. and Minnesota flours which carry about 12 per cent. In no case did the moisture content fall as low as those indicated for the Canadian flours, and in three instances it rose above 14 per cent.

To a certain extent this difference in moisture will account for the difference in the amount of bread that can be made from flours produced in those sections as compared with the Coast flours. This same will undoubtedly apply to flours in the interior of the State as compared with those in the coast section. For the bread maker this is quite an important matter, since, other things being equal, the drier the flour the greater the weight of bread that can be made from it.

Nitrogenous Compounds.—It was observed in the case of wheat that the total per cent. of proteids was low. The average protein content of the wheat milled was 8.57 per cent. and the average of the flours milled from them was 7.03 per cent. or about 82 per cent. of the total protein of the wheat passed into the flour. Quite generally the amount of proteids found in flour depends upon the amount contained in the wheat, though it does not follow in every case that the wheat with the

highest proteid content yields a flour with the highest percentage of proteids.

Total Protein.—In the matter of total protein the flours take the following rank: Propo, 7.83 per cent.; White Australian, 6.73 per cent; Bluestem, 6.61 per cent; Little Club, 6.59 per cent; Sonora, 6.39 per cent, the general average being 7.03 per cent.

As to the proportion of protein which passed into the flour in each variety the following will show the relation by varieties:

White Australian	80.2
Bluestem	79.4
Little Club	84.4
Sonora	85.1

Gluten.—The nature of gluten has already been discussed in the earlier pages of this bulletin and need not be repeated here. The percentages set forth in the table refer only to the chemically determined gluten consisting of the gliadin plus the glutenin.

Considering the relation of gluten to total proteids in wheats and their corresponding flour, the average relation is as follows:

	Wheats.	Flours.
White Australian	83.9	96.1
Bluestem	82.6	97.1
Little Club	77.0	98.6
Propo	---	98.8
Sonora	81.7	93.1

The relation of gluten proteids to the total proteids is very different in these flours from that existing in the common wheats of the Middle West. Snyder has stated that the best bread-making qualities of a flour obtain when the gluten proteids are about 85 per cent. of the total proteids. If this is also true of the soft wheats then we may attribute a poor quality of our flour in part at least to the unbalanced relation of gluten to the total proteids. The averages for each type namely, Bluestem, 97 per cent; Club, 97 per cent; Australian, 95 per cent.; Sonora, 95 per cent.; show how far different this relation is from that found in eastern wheat.

The quantitative, wet-gluten determination was carried through with a considerable number of the flours, but the results, as compared with the chemical determinations, were so inconsistent that they will not be given.

The wet gluten as determined was in each case dried and the per cent. of dry gluten determined. These figures are fairly consistent and reliable. Subtracting the percentage of dry gluten from 100 gave the per cent. of moisture held by the gluten. The range of variation was from 53.3 per cent. to 64.3 per cent. (?) The relation between the moisture content and the expansions made on the gluten are fairly constant on averages. The higher the amount of moisture retained by the wet gluten the larger the expansion. In a general way the expansion

fluctuates with the amount of gluten. There are certain distinctive characteristics of these soft white-wheat glutens which are of interest at this point.

The gluten test as quite generally made where flour is studied is not at all satisfactory when applied to soft wheat flours. The first difficulty encountered in its application is the small amount of the proteids contained in the flour. In attempting to wash a flour with a low gluten content, the proportion of gluten is so small that it makes it almost impossible to get the fine particles into contact before many are carried away with the water.

WASHED GLUTEN TESTS NOT RELIABLE.

The nature of the gluten is a second difficulty. It acts entirely different in the hand from eastern flours. The first difference is noticed in the dough; a soft wheat dough can be distinguished very easily, especially if not of the best quality, by its being perfectly smooth on the surface after the dough has been worked and is ready for washing. The standard dough is soft and spongy, while the soft wheat dough is firmer and more tenacious, and works very much like a soft putty. The dough on being worked has a marked tendency to stick to the hands and the utensils. The standard dough, while also having that quality, does not have it to the same degree. The two doughs differ much in this respect, that, while they are both tenacious, the standard dough is very cohesive and will not permit its body to separate while the soft wheat dough will in nearly all cases. Of the total fifty-eight doughs made, only three or four approximated the standard in their handling qualities.

The next noticeable feature these doughs present is in the surface of the doughs when placed side by side. The poorer dough has the smoother surface. The better the quality of the gluten the more uneven is the surface. There are no abrupt grooves or ridges upon it, but there are small, circular, uneven, bullet-like prominences. The further in the process this dough goes the more pronounced this becomes. They are especially noticeable in kneading the dough back the second or third time. On a poor-gluten flour this structure is never seen, not even in kneading back. The more a dough is worked after raising, the less noticeable these irregularities become. Their appearance on the dough, after making the water-absorption test, generally gives a very fair idea of what is to be expected in the volume of the loaf.

In washing a poor and a good quality of gluten from flour there appears again an indication of the relative qualities of the good gluten dough, the gluten masses appear distinct, even from the very beginning, and they are much more apt to stick to the dough ball than to the hands. The standard never sticks to the hands. The particles may occasionally be separated from the mass, but not so often as those from the poorer gluten doughs. On washing a dough of inferior quality the

gluten masses do not appear as soon; when they do become visible, they are not distinct and clean, but mixed with more starchy paste. This will stick to the hands and apparently has little affinity for the ball of dough. The very poorest doughs will go to pieces in the process, and always tend to form a paste rather than a separation, and it makes little, if any, difference even though the wash water be used drop by drop. A good washed gluten will be firm and very much like gristle at first, but will work down after awhile to a very elastic and well-mixed mass. The gluten of poor quality will be soft and indifferent, and soon works into a smooth, soft mass that has little recoiling ability, and when placed upon a cardboard to dry, if it is not dried at once, it is very likely to run all over the cardboard, thus showing its low strength.

Considering the mechanical separation of gluten, as applied to the soft or white wheat flour, it is not satisfactory, as stated before. In the most troublesome instances only about one half of the amount was recovered. This leads to the belief that perhaps some of the proteids of these wheats are partly soluble in water and are washed away, thus adding to the mechanical loss. Some flour was set for four hours in cold water, filtered, and the nitrogen in the filtrate determined, with the result that from 12.48 to 17.90 per cent. of the total proteids were found water-soluble. As was previously stated, about 97 per cent. of the total proteids in flour are in the form of gluten. Therefore, some of the gluten amounting to the difference in these two percentages must be soluble in water. The alcohol extraction of the residue showed that from 25 per cent. to 58 per cent. of the gliadin was removed. From samples containing small and large amounts of gluten, the total amount of soluble proteids is larger in the high gluten flours and gradually falls as the gluten content decreases. The decrease in the soluble proteids is not as rapid as in the gluten content, so that the percentage amount of soluble proteids to the total amount of proteids gradually increases and is highest on the flour with the lowest total proteids, thus tending to concentrate the error in the method upon the poorer grade of flour.

Gliadin.—Gliadin has been given much consideration in most discussions of flour. It seems hardly worthy of so much stress as has been given it, especially as regards the white wheats. The gliadin is said to impart the tenacity and adhesiveness to the gluten. While this may be largely true, it does not seem to apply so generally to the white wheats. The total average of gluten in the form of gliadin is less than 50 per cent. The standard contains 53 per cent., which is lower than is usually found in eastern spring wheat flours.

There is a very decided difference in the tenacity of the average California flour gluten and the standard; the Californian being the more tenacious and very soft, and still has the lower amount of gliadin, not

only as figured on the gluten, but those that are figured to the total amount of proteids, and contain a lower percentage than the standard on the same basis.

An examination of the table shows that in nearly every case the gliadin content of the flour is higher than that of its corresponding wheat, and that this difference is much more marked in the wheats carrying the larger per cent. of protein.

While the gliadin increases towards the outside of the kernel, there are some instances in which the reverse appears true, which may be inferred from the lower percentage of gliadin in the flour than in the wheat. In one sample the gliadin-number in the wheat and in the flour remains the same. Since all of these percentages are found, they would suggest that variations in every way in the distribution of the gliadin in the grain do occur. The data is, however, insufficient to fully establish this as a fact.

Gliadin-Number.—By the gliadin-number is meant the percentage which the gliadin is of the total protein.

In most cases the gliadin-number is increased in milling, that is, the flour shows a larger percentage of gliadin than the corresponding wheat, thus showing the wheat to carry a larger percentage of gliadin in the inner portion of the grain. The average gliadin-number for these samples was 48.6 for the flours as against 33.4 for the wheats, or an average increase of about 4 per cent. by milling.

The range in gliadin-numbers was between 34.2 in No. 268 and 69.3 in 41*a*. Considering the matter by varieties Propo leads with 51.6. Were the gliadin-number the only factor which should be considered in relation to the baking value, or even the determining factor, then Little Club flour with an average of 51.6 should stand close to Propo, but that this is not so is not only the common experience, but is also shown in the fact that the average volume of the Club loaves was only 76 cubic inches as against 83 and 85 cubic inches, respectively, for White Australian and Bluestem.

That the effect of gliadin ratio may often be overshadowed by the total amount of gluten is clearly shown by a series of bakings made from flour having the same gliadin ratio (50:50), but a varying total gluten content.

The gluten content of the flour and the volume of each resulting loaf is shown below. The series of loaves is shown in Figure No. 16.

No.	Gluten.	Volume.
8	10.11	97 cu. in.
9	9.37	87 cu. in.
10	6.92	83 cu. in.
11	5.50	66 cu. in.
12	4.70	61 cu. in.

Here it may be seen that notwithstanding there is the same gliadin-number the volume of loaf follows the order of the total protein.

FIG. 16.—Showing effect of protein content on volume of loaf, the gliadin ratio remaining the same.

TABLE XIX.—SHOWING CHEMICAL CHARACTERISTICS OF WHITE WHEATS AND THE RESULTING FLOURS AND ALSO THE BAKING VALUE OF THE FLOURS.

White Australian.

Number.	Original wheat.								Corresponding flour.												
	Moisture.	Total protein.	Gluten.		Total gluten.	Gliadin number.	Non-gluten protein.	Ash.	Moisture.	Total protein.	Gluten.		Total gluten.	Gliadin number.	Non-gluten protein.	Ash.	Absorption.	Loss in baking, per cent.	Weight of loaf.	Volume of loaf, cubic inches.	Loaves per barrel.
			Gliadin.	Glutenin.							Gliadin.	Glutenin.									
62a	11.87	9.64	3.43	4.75	8.18	35.6	------	1.83	13.02	7.97	4.15	3.54	7.69	52.1	.28	.47	51.5	13.0	46.9	90	270
41a	11.38	11.72	4.23	5.61	9.84	36.1	1.88	1.64	13.04	7.80	5.42	1.86	7.28	69.3	.52	.55	53.8	12.1	48.0	88	276
304	8.88	9.25	2.95	4.54	8.22	31.9	1.76	1.81	12.67	7.47	3.47	3.40	6.87	46.4	.60	.52	51.2	11.9	47.6	84	274
251	12.54	8.46	2.24	4.84	7.10	26.5	1.36	1.74	13.72	7.02	3.34	3.55	6.89	50.6	.13	.49	49.1	14.0	45.2	82	260
320	12.09	8.70	2.63	4.71	7.34	30.2	1.36	1.65	13.74	6.96	3.15	3.68	6.83	45.3	.13	.43	47.9	6.0	49.7	89	286
231	12.18	6.78	2.15	3.44	5.59	31.7	.52	1.69	13.05	5.86	2.33	3.41	5.74	39.8	.12	.45	52.9	8.7	49.9	78	287
232	12.54	6.06	2.07	2.79	4.86	34.2	1.20	1.69	12.89	5.42	2.28	2.97	5.25	42.1	.17	.52	52.7	10.1	49.0	80	282
259	11.23	6.54	1.65	3.53	5.18	25.2	1.36	1.80	13.84	5.31	2.58	2.60	5.18	48.5	.13	.54	48.2	12.0	46.8	69	269
Average	10.34	8.39	2.67	4.37	7.04	31.8	1.35	1.73	13.24	6.73	3.34	3.13	6.47	49.3	.26	.49	50.9	10.9	47.9	83	275

Bluestem.

19a	13.68	9.64	3.07	5.17	8.24	31.9	1.40	1.65	12.43	8.62	4.31	3.90	8.21	50.0	.41	.57	52.4	11.2	48.4	92	278
196	9.18	9.25	3.30	4.59	7.89	35.7	1.36	1.79	13.39	8.14	2.80	4.96	7.76	34.4	.58	.48	50.0	13.4	45.5	86	262
25	12.64	12.12	4.07	6.18	10.25	50.9	1.10	1.78	12.64	7.88	4.23	3.42	7.65	53.7	.23	.43	52.9	13.0	47.6	93	274
17a	11.76	10.51	4.71	2.72	7.43	44.8	3.08	1.88	12.81	7.25	3.75	3.34	7.09	51.7	.18	.47	52.9	14.0	47.1	93	271
10a	11.89	7.72	2.55	3.85	6.40	33.0	1.32	1.75	12.72	7.08	4.43	2.42	6.85	62.6	.23	.54	52.4	12.0	47.6	81	274
289	14.30	7.97	2.24	4.37	6.61	28.1	1.36	1.60	14.02	6.74	3.58	3.03	6.61	53.1	.13	.52	47.6	11.0	46.8	88	269
299	9.44	7.32	2.83	3.13	5.96	38.7	1.36	1.76	13.65	6.62	2.67	3.83	6.50	40.3	.12	.36	51.4	11.0	48.1	79	282
386	12.18	8.37	2.71	4.34	8.03	32.3	1.32	1.42	13.12	6.38	2.51	3.81	6.32	39.4	.06	.43	51.8	11.2	48.2	85	277
303	9.68	8.41	2.87	4.39	7.20	34.1	1.76	1.48	13.87	5.99	2.83	3.03	5.86	47.1	.13	.43	53.8	13.6	47.2	87	272
325	12.34	7.47	2.25	3.86	6.11	30.1	1.36	1.65	13.53	5.71	2.95	2.63	5.58	51.5	.13	.41	46.8	13.0	45.9	79	264
260	12.07	6.78	1.67	3.75	5.42	24.6	1.36	1.70	13.80	5.27	2.40	2.74	5.14	45.5	.13	.72	40.7	12.0	46.4	83	267
272	13.06	6.22	1.94	3.30	5.24	30.2	.78	1.75	13.12	5.22	2.51	2.07	5.18	48.1	.04	.36	52.1	13.0	47.4	80	273
268	12.44	6.38	2.23	2.97	5.18	34.9	1.20	1.75	13.96	5.10	1.75	3.35	5.10	34.2	------	.42	51.8	6.7	49.6	76	285
Average	11.88	8.32	2.80	4.08	6.88	34.6	1.44	1.69	13.31	6.61	3.13	3.29	6.42	47.0	.19	.47	50.5	11.9	47.3	85	273

Little Club.

233	12.12	10.11	3.67	4.68	8.35	36.3	1.76	1.80	13.39	9.37	4.43	4.43	8.86	47.2	.51	.53	49.4	9.9	48.3	87	278
169	11.84	10.60	3.27	5.33	8.60	30.9	2.00	2.07	12.46	8.29	4.82	3.01	7.83	58.2	.46	.46	55.5	14.0	47.4	83	270
163	11.98	9.09	3.43	4.34	7.77	38.2	1.32	1.93	11.32	7.32	3.83	3.26	7.09	52.4	.23	.55	53.5	10.0	49.5	92	285
51a	11.77	8.13	2.55	4.42	6.97	31.4	1.14	1.92	13.13	6.54	3.27	3.15	6.42	49.8	.12	.44	51.8	12.6	47.4	89	273
317	11.09	7.25	2.63	3.14	5.77	36.3	1.48	1.70	13.96	5.02	2.67	2.23	4.90	54.9	.12	.43	50.3	7.9	49.6	71	285
266	12.48	6.46	2.23	3.07	5.30	34.5	1.16	1.73	13.80	4.94	2.47	2.35	4.82	50.1	.12	.44	52.1	9.4	49.3	63	283
253	12.90	6.54	2.31	2.99	5.30	35.3	1.24	1.92	13.82	4.71	2.27	2.44	4.71	48.1	------	.32	50.6	11.0	47.8	61	275
Average	12.03	8.31	2.87	3.53	6.40	34.7	1.44	1.87	13.13	6.59	3.39	3.02	6.41	51.5	.26	.45	51.9	10.7	48.9	76	278

Propo.

480	------	------	------	------	------	------	------	------	13.35	9.33	4.55	4.65	9.20	48.8	.13	.44	50.9	13.0	47.0	91	271
226	------	------	------	------	------	------	------	------	13.50	7.73	3.98	3.62	7.60	51.4	.13	.60	47.9	13.3	45.9	81	265
225	------	------	------	------	------	------	------	------	13.48	7.47	4.03	3.31	7.34	53.9	.13	.59	48.5	11.6	47.0	85	271
468	------	------	------	------	------	------	------	------	13.35	6.79	3.55	3.11	6.66	52.3	.13	.45	51.5	12.0	47.7	80	275
Average	------	------	------	------	------	------	------	------	13.42	7.83	4.03	3.67	7.70	51.6	.13	.52	49.7	12.5	46.9	84	270

Sonora.

481	12.45	8.77	2.95	4.22	7.27	33.6	1.50	1.60	13.03	7.49	3.72	3.77	7.49	49.7	------	.42	51.5	13.0	47.1	78	272
248	12.02	7.32	2.55	3.41	5.96	34.8	1.36	1.82	14.76	6.46	2.55	3.59	6.14	39.4	.32	.42	52.6	8.0	50.2	78	289
249	12.05	8.21	2.83	4.14	6.97	34.5	1.24	1.67	13.66	6.54	2.51	3.80	6.31	38.4	.23	.44	53.8	10.2	49.3	69	284
254	12.16	7.47	2.55	3.73	6.28	34.1	1.19	1.55	12.96	6.65	2.47	4.18	6.65	43.1	------	.47	54.4	11.7	48.8	77	281
228	12.53	6.86	1.98	3.52	5.50	28.9	1.36	1.70	13.41	6.00	2.47	3.53	6.00	41.3	------	.63	51.1	11.0	48.2	77	278
257	12.34	7.04	2.27	2.57	4.84	32.2	1.20	1.74	14.49	5.90	2.95	2.63	5.78	50.0	.12	.45	52.6	8.5	49.9	81	287
269	12.54	7.00	2.00	3.64	5.64	28.6	1.36	1.75	14.13	5.72	2.87	2.87	5.74	50.0	------	.52	48.5	13.0	46.2	77	266
Average	12.29	7.52	2.48	3.72	6.20	32.4	1.32	1.69	13.77	6.39	2.78	3.18	5.96	44.5	.23	.46	52.1	10.8	48.5	77	279

BAKING TESTS.

A number of the flours were subjected to a baking test to obtain a better knowledge of the actions of this class of wheat alone in the oven for the sake of comparison in later work.

The baking test furnishes the most accurate and reliable data as to the relative merits of flours. The bread is the ultimate product, no matter what has been indicated by previous tests. Though other tests usually assist much if given proper consideration and value in enabling one to establish right relations of flours; the baked bread is the one way in which all are able to judge of a flour value; the final test then is to decide which produces the better bread in large amounts.

THE METHODS.

The Strength or Water Absorption.—The strength of a flour is measured by its water-absorbing capacity in making a dough of given consistency. It is a factor which varies considerably with different flours even from the same variety of wheat. It is of much importance in determining the baking value of a flour.

The water-absorption of a flour, other things being equal, is indicative of the amount of gluten the flour contains and its quality. The larger the amount of the gluten or the better quality of the gluten, generally speaking, the more water it will take to make a dough of certain consistency. For bakers, a flour to which they can add a maximum amount of water and still have a loaf that will rise well and present an even texture and good color, is most desirable. The larger the amount of water absorbed by a flour, the more loaves can be produced per given weight of flour. Since the relation is a fairly constant one, the relative water-absorption number of flours compared is expressed, with other things, by the number of one-pound loaves produced per barrel of flour, provided the comparison is made under like conditions.

A peculiar quality very noticeable in all these flours is that of the dough becoming soft. There is constant danger of adding too much water; in this one feature the California flour differs from the standard flour as much as in any. Upon this depends the quality of the bread more than any other one factor. If there can be a reason given for this, it would be a long step towards explaining the whole difference between the Pacific coast flour and flour from the remainder of the continent.

The capacity of a flour for holding a large amount of water in the dough bears an approximate relation to the total per cent that the gluten protein bears to the total protein. The larger this percentage the more

water the flour will absorb. The relation also extends to the gliadin contained in the gluten. Two flours with the same percentage of gluten usually will require water according to the amount of gliadin contained.

The Method.—The water absorption or "strength," is determined by making a standard dough from a flour selected as a standard by adding a sufficient amount of water to give a dough of rather stiff consistency. This is about 17.5 cc. of water to 30 grams of flour for standard spring wheat flour, and 16.7 cc. for winter wheat flour, and 15.7 cc. for white wheat flour, when made to the same consistency, the exact amount of water required is noted. From this can be calculated the necessary amount of water for any given amount of flour. The amount here used was 340 grams of flour with from 161 to 189 cc. of water. To this was added 10 grams of fresh compressed yeast, 12 grams of sugar, 5 grams of salt, and a little lard. Two thirds of the flour was beaten up with the water for ten minutes, the remainder of the flour then added and the whole kneaded for ten minutes more. The yeast was previously added to the measured water and allowed to stand for fifteen minutes before being mixed with the flour. All utensils and apparatus were kept at about 95° Fahrenheit.

On removing the dough from the kneader it was made into two small loaves and weighed into a bread pan which was placed in an electric cupboard or expansion box at 95°F. Here it was allowed to rise for an hour and a half, re-kneaded and set again. When the dough had risen even with the top of the pan it was at once placed in an electric oven at 400–425° for thirty-five minutes. After cooling, the bread was weighed and its volume taken by placing the bread in a box of known volume, filling the unoccupied space with flaxseed, and measuring the seed required; the difference in the volume of seed and the volume of the box giving the volume of the loaf.

TABULATION AND CALCULATION OF RESULTS.

340 grams of flour used.
158 cc. water required for dough.
10 grams of yeast.
12 grams of sugar.
5 grams of salt.

525 grams of dough.

706 weight of pan and contained dough.
191 grams weight of pan.

515 grams of dough in the pan.

10 grams of dough left in the kneader.

515 grams of dough in pan.
488 grams of bread.

27 grams lost in baking.

27 is 5.2 per cent. of 515, or the per cent. of the weight baked out.

5.2 per cent. of 10 is .5 grams the loss on the 10 grams had it been baked.

27 grams given loss in baking.
.5 loss on 10 grams in the kneader.

27.5 loss on total dough.

525 grams of total dough.
27.5 grams loss in baking.

497.5 weight of loaf if all the dough were baked.
454.5 grams in a one-pound loaf.

43.0 grams overweight when calculated to a one-pound loaf.

A barrel of flour (196 pounds) equals 89,082 grams. When 340 grams are used per loaf there should be 262 loaves made from a barrel of flour.

43 times 262 equals 11,266 grams overweight produced in one barrel of flour.

454.5 grams equals one pound.
11266 divided by 454.5 equals 24 loaves in overweight.
262 loaves of 340 grams flour each in one barrel.
24 loaves gain in overweight.
286 loaves (weighing one pound) made from the tested flour.

Volume.—The volume of a loaf of bread is even more dependent upon the quality of the gluten than upon its quantity. After the pan of bread is placed in the oven, the high temperature increases the volume of the gas within the loaf, and also causes the formation of steam, which together tends to expand the dough. If the dough is coarse and not elastic, the gases escape through the pores into the oven, but if the gluten in the dough is of good quality it keeps these gases enclosed which cause the volume to increase.

If from Table XIX we select the results indicating the nine best loaves, as measured by their volume, arranging them in order and for the sake of contrast select and arrange the results from the poorest nine loaves we have some very interesting and suggestive data. (See Table XX.)

The general trend of results is clearly seen. Two unusual occurrences must be noticed. The first is the relation of the water holding capacity or absorption to the gluten content, and to the amount of gliadin to the gluten content. We would expect to find more difference in the absorption number than is shown, since the quality of the gluten is very evidently different, as is shown by the volume of the loaves. The second is the relation of the gluten and loaf volume to the number of loaves that may be produced from a barrel of flour. Ordinarily, we would expect the loaf production to increase with the amount and quality of the gluten. This would, probably, hold with flour of average to good quality, but with a poor flour, the loaf is coarser in texture and has a

smoother crust, and a smaller surface exposed, so that the loss between the weighing into the pan in which it is allowed to rise and the time it is baked may be considerably different. Then, too, the larger volume of the dough from good flour at the first kneading permits of much more water being carried off when the gases are worked out.

TABLE XX.—RESULTS OF BAKING TESTS.

Laboratory number.	Total protein.	Gluten.	Gluten, per cent of protein.	Gliadin.	Gliadin, per cent of gluten.	Gliadin number.	Absorption.	Loss in baking.	Volume of loaf, cubic inches.	Number laboratory loaves per barrel.
25	7.88	7.65	97.0	4.23	55.3	53.7	52.9	13.0	93	271
17a	7.25	7.09	97.8	3.75	52.9	51.7	52.9	14.0	93	274
163	7.32	7.09	96.9	3.83	54.0	52.4	53.5	10.0	92	285
19a	8.62	8.21	95.2	4.31	52.5	50.0	52.4	11.2	92	278
480	9.33	9.20	98.6	4.55	49.5	48.8	50.9	13.0	91	271
320	6.96	6.83	98.1	3.15	46.1	45.3	47.9	6.0	89	286
51a	6.54	6.42	98.2	3.27	50.9	49.8	51.8	12.6	89	273
41a	7.80	7.28	93.3	5.42	74.5	69.3	53.8	12.1	88	276
289	6.74	6.61	98.1	3.58	54.2	53.1	47.6	11.0	88	269
Average	7.64	7.38	97.0	4.01	54.4	52.7	51.5	11.4	90.5	276
[illegible]	4.71	4.71	10.0	2.27	48.1	48.1	50.6	11.0	61	275
266	4.94	4.82	97.6	2.47	51.2	50.1	52.1	9.4	63	283
259	5.31	5.18	97.6	2.58	49.8	48.5	48.2	12.0	69	269
249	6.54	6.31	96.5	2.51	39.8	38.4	53.8	10.2	69	284
317	5.02	4.90	97.6	2.67	54.5	53.2	50.3	7.9	71	285
268	5.10	5.10	100.	1.75	34.3	34.3	51.8	6.7	76	285
254	6.65	6.65	100.	2.47	37.1	37.1	54.4	11.7	77	281
228	6.00	6.00	100.	2.47	41.2	41.2	51.1	11.0	77	278
269	5.74	5.74	100.	2.87	50.0	50.0	48.5	8.5	81	287
Average	5.56	5.49	98.8	2.45	45.1	44.5	51.2	9.8	71.5	281

In Figure 17 (upper row) is shown the volume and character of loaves produced from certain flours of these wheats, No. 5 showing a loaf from a particularly good type of Little Club wheat flour from the crop of 1904, which gave a volume of 86 cubic inches; No. 7 made from a Sonora flour, also of the crop of 1904, but having a volume of only 76 cubic inches; No. 6 being from a Little Club flour, crop of 1905, and showing a volume of only 71 cubic inches.

In the lower row of the same plate are three illustrations showing that an increase of the gliadin ratio does not entirely govern the volume of loaf. The flours selected to show this had a widely varying gliadin number, but the gluten content was essentially the same, viz.:

Number.	Protein.	Gliadin number.	Volume.
268	5.10	34.66	76
272	5.22	48.52	82
317	5.02	54.65	71

FIG. 17.—Relation of volume to gliadin ratio.

First, the higher the gluten the larger the volume of loaf, other things being equal.

Second, it seems to further show that an increase in the gliadin ratio is favorable to the production of a better loaf. This, together with the fact that the gliadin number and protein content of these wheats are both relatively low *would seem to indicate that the generally poor quality of these flours is due to a lack of development of glutenin rather than of gliadin.*

Third, the absorptive power in these wheats would seem to have no close relation to the loaf volume, as the loaf volume varies widely in these two groups while the absorptitve power remains essentially the same.

Table No. XX shows that the volume of the loaf is not parallel with the gliadin number. There is shown, however, a somewhat general relation between the volume of the loaf and the percentage loss in the process of baking. This relation is quite constant. The larger the volume of a loaf, the larger the amount of loss in baking and the lighter and whiter the bread becomes. The whiter and lighter loaves have been shown to be the more nutritious than heavier and darker ones. These two characters are very important then, and since the amount of loss in baking is an indication of each, when the comparison is made between breads from similar flours, it is a valuable determination.

The number of loaves of bread of the same size that a flour will yield is a matter of considerable importance and one that is very carefully considered by the bakers. The ordinary housewives would do well to pay some attention to this feature.

In the flours studied this variation ranged from 260 up to 289 one-pound loaves per barrel and in the case of standard 297 loaves per barrel, with a volume as high as 108 cubic inches.

Texture.—The texture of the loaves is seen on cutting them open after they have cooled. In deciding upon this, account is taken of the color of the crust and crumb, the crust should present fine even pores with no roughness or cracks. The crumbs should be uniform throughout as regards evenness and the size of the pores. The body should be moist, soft, and friable. When touched with the finger, it should leave no dent. The membraneous partitions between the pores should be even and thin. In no case should there be any unexpanded masses either glutinous or floury.

In general, the texture of loaves from these flours was poor, not that it was due to insufficient working of the dough or insufficient time in rising, but rather to the quality and quantity of the gluten. In many instances the loaf broke, and in others the crust remained intact but the crumb had not developed evenly. We may say that those flours with less than 5.25 per cent. proteids can not be baked into well-formed loaves under our conditions. Were it attempted to have them raise to the same height in the pan as is common with eastern flours, there would be few that could stand the test.

SEASONAL EFFECT ON CHARACTER OF LOAF.

The following illustration (Figure 18) fairly represents the general difference in the flours as affected by the season as shown in the baking. Nos. 1 and 3 were from the crop of 1904 and Nos. 2 and 4 from the crop of 1905, all the flours of the latter season giving poorer results than those of 1904.

The figures for the loaves are subjoined:

	1904.		1905	
	No. 1 (62a).	No. 3 (19a).	No. 2 (231).	No. 4 (10a).
Total protein	7.97	8.62	8.62	7.08
Gliadin	4.15	4.31	2.33	4.43
Gliadin number	52.0	5.00	39.8	62.6
Volume of loaf	90 cu. in.	92 cu. in.	78 cu. in.	81 cu. in.

FIG. 18.—Showing difference in loaf as affected by season.

Acidity.—The acidity of Californian white wheats is rather low. This may be expected when we remember that the latter part of the growing season is passed in a warm and dry condition, there being no rain to keep the grain green. Then, too, the grain is well matured and perfectly dry by reason of being left standing so long before the harvest can be completed. So there is very little immature or "musty" wheat. The flour contains less fat and less branny portion with foreign particles, thus the chances for fermentation are fewer, and the acidity lower. The determination was made on five grams of flour using one tenth sodium hydrate with phenolphthalein and the result calculated to lactic acid. The range was from .049 to .165 per cent and averaging .095 for all. The following tabulation gives the maximum average, and minimum for the flours from the different wheats.

Kinds of Flours.	Maximum.	Average.	Minimum.
Bluestem	.1086	.0879	.0660
Australian	.1650	.0999	.088
Club	.1485	.0890	.0495
Sonora	.0976	.0945	.088
Average for all		0950	
Standard		.112	

For the purpose of comparing the proximate analysis of the type of wheats with the corresponding flours, those samples which were used for milling and baking tests were subjected to complete analysis and the results are contrasted in the following table:

	Australian.		Bluestem.		Little Club.		Sonora.	
	Wheat.	Flour.	Wheat.	Flour.	Wheat.	Flour.	Wheat.	Flour.
Moisture	10.34	13.24	11.88	13.31	12.03	13.13	12.29	13.77
Ash	1.73	.49	1.69	.47	1.87	.45	1.69	.46
Total protein	8.39	6.73	8.32	6.61	8.31	6.59	7.52	6.39
Crude fiber	2.39	.19	2.78	.09	2.69	.12	2.12	.07
Nitrogen-free extract—								
Fat	1.42	1.00	1.60	.96	1.57	.95	1.41	1.10
Gliadin	2.67	3.34	2.82	3.31	2.94	3.39	2.48	2.78

Ash.—The ash of these wheat flours is very low, averaging .55 per cent. and ranging from a minimum of .32 per cent. in Little Club 253 to a maximum of .72 per cent. in Bluestem 260.

Fat and Fiber.—Both of these groups are so low as to not appreciably affect the flour. The fat averages but .98 per cent. as against 2.24 per cent in Minnesota flours (Minn. Bul. 74, p. 157), and 1.85 for Canadian wheats (Bul. 50, Central Exp. Farm, Ottawa, Canada). This low fat content may explain the high keeping quality of these flours. Certain it is that the Minnesota "Standard" brought from Minnesota at the beginning of these experiments has deteriorated very noticeably within six months, while the native flours do not show any appreciable change.

BRAN, SHORTS, AND LOW GRADE FLOURS.

Bran, shorts, and the low grade flours are the by-products produced in the manufacture of flour. The floury, white content of the grain is the valuable portion. The by-products consist of the fibrous coverings of the kernels, the germ and unavoidable loss of the starch which is removed along with the undesirable parts. The yield of each depends upon the kind and condition of the grain, upon the method of milling and upon the skill of the miller. By improperly supplying the grain to the rolls and manipulating of the streams after bolting, a large amount of flour may find its way into the feed stuffs or some of the feed stuffs may be turned into the flour streams and thus affect not only the color and quality of the flour, but also impair its breadmaking quality and its nutritive value. The bran and shorts are not very different either in the nature of the material or in the composition. In years past, when the flour was not so completely removed, the shorts had considerable more value as a foodstuff than bran, as it contained considerably more of the middlings which the then used process could not reduce, the bran being left in a coarser condition. But the improved methods

have swept away this difference. The shorts is now a little more than finely ground bran with perhaps some ground screening and the sweepings added to it.

The low grade flour is composed largely of the germ parts, the very fine particles of bran and fibrous parts under the bran which are unavoidably obtained in the middlings. To this must be added the very fine specks of dust and hairs of the surface of the grain which were not previously removed, and the small amount of flour that is lost from the chop produced in removing the above débris. The amount thus turned into low grade flour may vary considerably, depending upon the condition of the grain, the process and the kind of flour being produced When milling for a straight grade flour from soft wheat, very little low grade flour need result to make it comparable to eastern straight flours.

In commercial milling, the bran and shorts may amount to 22 or 25 per cent of the grain used and the low grade flour from 2 to 10 per cent, or even more. On a small experimental mill it would be impracticable to get large yields of flour, and it is not necessary in order to obtain comparable results.

The attached Table No. XXI gives the results of the determinations made on the products. While they are comparable among themselves they are lower in every respect with the exception of the proteids, which are higher than they would have been had they been obtained in commercial milling.

TABLE XXI.—SHOWING AVERAGE ANALYSES OF BRAN, SHORTS, AND LOW-GRADE FLOUR FROM WHITE WHEATS.

BRAN.

	Moisture.	Ash.	Total protein.	Fat.*	Fiber.
Bluestem.					
Maximum	13.80	5.71	12.44	2.73	13.11
Average	12.84	5.29	10.39	2.27	11.55
Minimum	11.36	4.73	8.62	2.06	9.76
Club.					
Maximum	13.57	5.90	14.04	2.87	12.03
Average	12.19	5.59	10.73	2.67	10.61
Minimum	8.86	4.97	9.01	2.52	9.44
Australian.					
Maximum	13.53	6.01	15.22	2.53	10.96
Average	12.80	5.29	10.72	2.42	10.17
Minimum	11.86	4.46	7.80	2.29	9.47
Sonora.					
Maximum	12.85	5.20	10.11		
Average	12.60	4.82	9.04	2.35	8.41
Minimum	12.33	4.29	7.97		

*Determination made on composite sample.

SHORTS.

Bluestem.

Maximum	14.12	4.71	14.91	4.26	7.57
Average	13.22	4.10	11.79	3.99	6.98
Minimum	12.30	3.10	10.03	3.48	6.00

Club.

Maximum	13.99	4.84	14.28	4.51	8.17
Average	12.24	4.25	12.09	4.27	7 49
Minimum	11.29	2.89	9.83	4.06	6.44

Australian.

Maximum	14.02	4.89	16.74	4.35	7.77
Average	12.43	4.31	11.93	4.08	7.05
Minimum	11.51	3.68	8.70	3.71	6.49

Sonora.

Maximum	12.85	5.20	10.11	----------	--------
Average	12.60	4.82	9.04	3.81	5.79
Minimum	12.33	4.29	7.97	----------	--------

LOW-GRADE FLOUR.

Bluestem.

	Moisture.	Ash.	Total protein.	Fat.*	Fiber.
Maximum	14.14	2.47	13.32	2.92	1.86
Average	13.30	1.82	9.63	2.67	1.39
Minimum	11.68	1.25	7.80	2.27	1.07

Club.

Maximum	13.91	2.85	11.80	3.39	2.03
Average	13.01	1.35	9.18	2.82	1.72
Minimum	12.30	1.32	7.08	2.36	1.37

Australian.

Maximum	13.71	2.73	13.56	3.15	2.64
Average	12.88	1.96	10.05	2.70	1.98
Minimum	11.58	1.42	7.97	1.82	1.50

Sonora.

Maximum	13.70	2.14	9.49	----------	--------
Average	13.61	1.86	8.61	3.03	1.67
Minimum	13.52	1.63	7.72	----------	--------

* Determination made on composite sample.

Under shorts, there is a maximum of total protein in the Australian wheats given of 16.74 per cent. This is of interest in that it suggests a wheat with a high protein content. Tracing it back to the wheat we find it has 15.22 per cent in the bran, 13.56 per cent in the low grade flour, 11.72 per cent in the whole wheat and only 7.80 per cent in the flour. This, then, is a case of high protein wheat yielding a flour with a relatively low amount. This suggests the need of looking further than to the nitrogen content of a wheat as indicative of its value for the improving the bread-making quality of the same. This same wheat has also a fair amount of gluten, having 90 per cent. of the total proteids in the form of gluten.

SOME CONCLUSIONS.

(1) The California white wheats have a low nitrogen and protein content.

(2) The larger normal kernels usually carry a higher per cent. of nitrogen than smaller normal kernels of the same type.

(3) The California white wheats are relatively high in fiber and low in ash and ether extract as compared with the hard winter wheats.

(4) The wheat crop of 1905 contained a uniformly lower nitrogen content than did the crop of 1904.

(5) The overlap of gluten nitrogen in the salt soluble extract is represented in the case of white wheat meals by the factor .15 per cent.; for flour .22 per cent.

(6) The polariscopic method for the determination of gliadin has proven very reliable.

(7) The mechanical separation of gluten in the case of this class of wheats is very unsatisfactory.

(8) The California white wheats contain a larger proportion of their total protein in the form of gluten than do most other wheats.

(9) The gliadin-number of these wheats is much lower than for those of the middle west.

(10) These wheats ordinarily produce a very white flour which bakes darker than the tinted flours from winter wheats.

(11) The water absorption of these wheats is relatively low. The white wheat flours absorb about 52 per cent., while the hard spring wheat flours absorb about 58 per cent.

(12) Loaves showing the greater loss in baking, other things being equal, are the lighter and whiter.

(13) Glutens from white wheat flours are not tenacious according as they contain more gliadin.

(14) The gluten of these wheats hydrolyze more than for other types of wheat.

(15) The glutens of these wheats are usually inferior in quality and dull in color.

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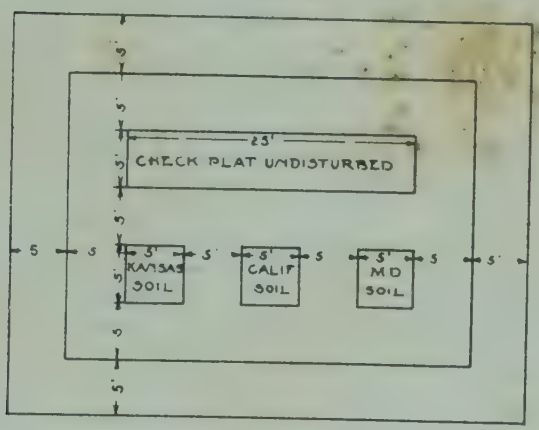
A Progress Report upon Soil and Climatic Factors Influencing the Composition of Wheat

By G. W. SHAW and E. H. WALTERS



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A PROGRESS REPORT UPON SOIL AND CLIMATIC FACTORS INFLUENCING THE COMPOSITION OF WHEAT.

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For many years the effect of environment upon the composition of grain has been the subject of much study by numerous investigators. The results of these investigations have been quite contradictory, and have resulted in a very wide divergence of opinion as to the factors which influence the gluten content of wheat. In practically all of these studies, the plan has been to transfer the seed from one point to another and grow it under a variety of conditions, and from the results so obtained attempt to draw conclusions as to the influence of environment upon the composition of the grain. In summarizing the reports of previous investigators in this field one notices that no experiments have been conducted under conditions which would eliminate all the varying factors, with the exception of the composition of the soil itself. In the experiments here reported, wheat from the same seed was grown under the same conditions on soils of widely different origin put under the same field influences, thus establishing the condition referred to above.

Many valuable practical results have been obtained from a study of soil fertility in connection with the chemical composition of the crop. But in the attempt to establish a relationship between the chemical composition of the soil and that of the crop grown upon it many difficulties arise. Soils contain varying amounts of the elements of plant food. In one soil these constituents may be in a form which can be readily assimilated by plants, while in another soil they may be present in sufficient quantities, but not in accessible forms. The utilization of one ingredient by a plant may be aided or retarded by the presence or absence of other soil ingredients. For example, in discussing the lime content of soils, Hilgard[1] shows that low percentages of phosphoric acid, nitrogen, and potash in the soil prove adequate in the presence of high amounts of lime. The physical and biological conditions of the soil, and the variations in climate and soil moisture, may also influence the assimilation of the plant food contained in the soil. With such complexities, the attempt to draw any definite conclusions from the results of a single investigation would be to depart from the correct scientific method.

* Note.—The bibliography of this paper and the chemical work relating to the second series of plats was done by Mr. Walters as a portion of his work for master's degree. The work relating to the first series of plats was done by the regular station officers.

[1] Hilgard's "Soils," p. 365.

This study is considered in two parts. Part one is historical, and an attempt is made to bring together some of the most important results of previous investigations already published. The literature devoted to this subject is voluminous, and this paper by no means attempts to quote from all of them. The writers believe, however, that it fairly represents the work relating to the particular phase of the subject discussed herein. Part two is devoted to the experimental phase of the study, the exact nature of which will be discussed in its proper place.

PREVIOUS RESEARCHES.

Plants are so sensitive to a change of environment that it is difficult to say which of the environmental factors have the greatest influence. Many investigators seem to think that the climate has the greatest effect upon the composition of the crop. Others believe that the soil has the greatest influence. It is a well known fact that true varieties, when grown in the same environment, have a tendency to produce a like product regardless of the original soil.[2]

In 1882, Richardson[3] commenced a study of the influence of environment on cereals, which consisted in growing crops from seeds of the same kind and of known composition in different localities. His results show that seeds of different varieties of wheat when grown in Colorado produced a crop which contained a higher protein and a lower carbohydrate content than the original seed. He also observed that the same seed, when grown in California, Oregon, and North Carolina, produced crops with a lower percentage of carbohydrates than the original seed. He concluded from the data obtained that the soil played the most important part in producing these changes.

Wiley,[4] in an article discussing the work of Richardson and reporting the work of later experiments, arrives at a different conclusion and states that the soil has the least effect of the environmental factors, provided, of course, that it contains the proper amounts of plant food, but that the length of the growing season is the most effective factor.

In 1884, Lawes and Gilbert[5] showed that a wider variation occurred in the potash and phosphoric acid content of the ash of wheat with the same manure in different seasons than under three very different conditions of manuring. This point is brought out very clearly in Table I, which is taken from their report.

[2]LeClerc, Bul. 128, Bureau of Chemistry, U. S. Dept. of Agr., Indiana Sta. Bul. 61, p. 60.
[3]Buls. 1, 4, and 9, Bureau of Chemistry, U. S. Dept. of Agr.
[4]Yearbook, U. S. Dept. of Agr. 1901, p. 299.
[5]Jour. Chem. Soc., London, 1884, XLV, p. 304.

TABLE I.

Highest, lowest, and mean percentage of potash, and phosphoric acid in the pure ash in sixteen consecutive seasons.

Plot.	Fertilizers.	Per cent in dry matter of grain		
		Highest.	Lowest.	Mean. 16 years.
	Potash.			
2	Farmyard manure	0.779	0.538	0.635
3	Unmanured	0.838	0.601	0.662
10a	Ammonium salts, alone	0.738	0.515	0.602
	Phosphoric acid.			
2	Farmyard manure	1.110	0.965	1.044
3	Unmanured	1.075	0.898	1.003
10a	Ammonium salts, alone	1.003	0.718	0.854

Considering the weight per bushel as the single factor in determining the quality of the crop, the same authors observed that the best crops are associated with low percentages of total mineral constituents (ash) and a low percentage of nitrogen in the dry substance. Accordingly, grain of high quality is associated with a high percentage of carbohydrates. In every case the lowest weight per bushel was associated with the lowest yield. Table II expresses some of their results.

TABLE II.

Maximum, minimum, and mean yields of each plot during sixteen years with the percentage composition of the crop.

Plot.	Weight per bushel.	Pounds grain per acre.	Percentage composition in dry matter of grain.						
			Ash.	Nitrogen.	Phosphoric acid.	Sulphuric acid.	Lime.	Magnesia.	Potash.
2	63.8	2068	1.93	1.58	0.97	.029	.049	.203	.637
2	51.1	1120	2.20	1.76	1.03	.052	.057	.223	.779
Mean	57.4	1967	2.06	1.96	1.07	.014	.054	.229	.640
3	62.7	1127	1.95	1.65	1.00	.013	.052	.212	.628
3	45.9	359	2.36	2.09	1.08	.057	.073	.243	.838
Mean	54.3	823	2.08	1.98	1.04	.029	.058	.217	.670
10a	62.6	2587	1.56	1.70	0.72	.037	.060	.175	.537
10a	48.6	642	1.98	2.43	0.88	.049	.074	.185	.709
Mean	53.7	1147	1.91	2.25	0.90	.039	.068	.205	.632

A study of Table II will show that in every case the ratio of nitrogen to phosphoric acid is greater in the crop of minimum yield, viz., an increase in the yield is associated with a decrease in the ratio of nitrogen to phosphoric acid. In the crop of minimum yield the percentage of ash, and therefore ash constituents, was higher than in the largest crop.

The results of grain grown on plots receiving very different manures but all under the same seasonal conditions are expressed in the following table:

TABLE III.

Analysis of wheat grown on plots receiving different manures.

Plot.	Weight per bushel.	Pounds dry matter per acre.	Percentage composition of dry matter in grain.						
			Ash.	Nitrogen.	Phosphoric acid.	Sulphuric acid.	Lime.	Magnesia.	Potash.
2	60.6	1963	1.96	1.80	1.038	.011	.050	.228	.593
3	58.5	836	2.01	1.85	1.035	.017	.054	.219	.630
5a	59.6	975	2.02	1.74	1.051	.013	.056	.222	.635
10a	58.4	1443	1.75	2.08	0.846	.031	.066	.199	.565
11a	59.0	1773	1.85	1.92	0.944	.020	.071	.205	.568
12a	60.1	2014	1.86	1.83	0.947	.019	.059	.203	.596
13a	60.2	1963	1.86	1.85	0.952	.015	.054	.203	.601
14a	60.0	2028	1.85	1.87	0.952	.018	.054	.209	.585
7a	59.6	2062	1.88	1.87	0.962	.010	.052	.218	.599

The different plots were fertilized as follows:

2. Farmyard manure.
3. Unmanured.
5*a*. Mixed mineral manures.
10*a*. Ammonium salts.
11*a*. Ammonium salts and superphosphate of lime.
12*a*. Ammonium salts, superphosphate and sulphate of soda.
13*a*. Ammonium salts, superphosphate and sulphate of potash.
14*a*. Ammonium salts, superphosphate and sulphate of magnesium.
7*a*. Mixed mineral manures and ammonium salts.

It will be noticed that with one exception, plot 5*a*, the nitrogen content is fairly uniform. Plot 5*a* received mineral manures alone and was deficient in nitrogen. On plot 10*a*, which received ammonium salts, and, therefore, an abundant supply of nitrogen, the nitrogen content was high and mineral constituents low. It will also be seen that the crop grown on plot 11*a*, which received applications of lime, contained a higher lime content than the crop grown on any of the other plots. On a whole the ash constituents show a marked uniformity. It appears, however, that they are directly influenced by their supply or exhaustion in the soil. *On a close study of their results the composition of the crop seems to reflect that of the soil.*

Von Liebenberg[6] and E. Von Proskowetz in 1893 found from fertilizer experiments in connection with the chemical analysis of the soil that the yield depends, not only upon an adequate supply of plant food in the soil, but upon the relation of nitrogen to phosphoric acid, the yield being higher the greater the proportion of nitrogen present.

Their results show that the ratio of nitrogen to phosphoric acid is greater in the crop than in the soil, and that the supply of nitrogen in the soil is drawn upon much more largely than that of phosphoric acid.

Schindler[7] stated that the composition of the grain depends upon the fertility of the soil. Also, that *a long growing period from the time of bloom to ripeness caused a low percentage of nitrogen in wheat*, that the

[6]Exp. Sta. Rec. (1893) Vol. V., p. 702; Abst.
[7]Bot. Centralb. 56 (1893), p. 345; Abst. Der Weisen, Berlin.

weight of the grain is affected by climate, and that the relation between the protein and carbohydrates is affected by the length of the growing period.

Cross and Smith[8] concluded from their investigations of the chemical history of the barley plant that *the condition of soil nutrition had little influence upon the composition of the plant.* "The plant, in other words, is, as regards soil nutrition, constant or invariable in respect to the relation of its products to assimilation."

In 1895 Januszowski[9] from experiments planned to determine the value of the plant analysis in estimating the quality of soil, found the results misleading, since a low phosphoric acid content, for instance, may be due not to the deficiency of that ingredient in the soil but to an excess of potash or nitrogen. He found that the application of phosphoric acid to a soil deficient in that element was followed by an increase in phosphoric acid in the grain grown on the soil, provided the application of phosphoric acid was not accompanied by liberal manuring with nitrogen.

Liebscher and Edler[10] noticed that the application of nitrogenous fertilizers increased the nitrogen content of oats, and that the exclusive application of potash caused a decrease in nitrogen and an increase in potash in the plant. With a complete fertilizer, the percentage of potash was lowest.

In studying the effect of humus on the percentage of nitrogen in oats, Wiley[11] conducted pot experiments which consisted in growing oats in peaty soil without manures and with various manures. The soil contained on the average less than 10 per cent of mineral matter, about 2.5 per cent of nitrogen, and very little potash and phosphoric acid. The crop was very high in nitrogen, of which much was present as amid nitrogen due to direct absorption from the soil. *The protein nitrogen remained within the limits of the usual amounts obtained in ordinary soil.* Potash and nitrogenous manures in the amounts applied had no effect upon the yield. Phosphates increased the yield and lowered the percentage of nitrogen, probably due to increased crop.

Von Seelhorst and Panaotovie[12] in 1889 observed that the nitrogen and ash constituents of cereals increased with an increase in space between the plants. In other words, within certain limits the nitrogen and mineral constituents in cereals vary directly as the feeding surface of the plants.

Bogdan[13] found that the increase of the salt content of alkali soils caused an increase in the nitrogen and ash contents of the grain grown

[8]Chem. News, 72 (1895) No. 1883, p. 307.
[9]Bied. Centr., 1895, vol. 28, p. 27.
[10]Jour. Landw., 1896, p. 84.
[11]Landw. Versuchs. Stats. 1897, vol. 49, p. 193.
[12]Jour. Landswirtschaft, 1899, vol. 47, p. 379.
[13]Exp. Sta. Rec. (1902) XIII, p. 329.

therein due to the fact that the absolute weight of the grain diminished. This, he says, explains the high protein content of wheat from the east and southeast of Russia, where the soils are rich in nitrates and other soluble salts.

Godlewski[14] in 1901 observed that in the case of potatoes the insufficiency of potash in soil narrowed the ratio of potash to phosphoric acid and of potash to nitrogen in the tubers. The inadequate supply of nitrogen caused the widening of the ratio of potash to nitrogen and narrowed the ratio of nitrogen to nearly all ash constituents. A low nitrogen content of the soil narrowed the ratio of nitrogen to phosphoric acid in barley straw without affecting the relation of the nitrogen to the other elements, while an insufficient amount of phosphoric acid widened the ratio to 5.1, and is considered as indicating lack of phosphoric acid in the soil. An adequate supply of potash in the soil reduced the potash content of barley straw to less than 1 per cent in the dry matter, increased the amount of nitrogen, lime, and magnesia, and narrowed the ratio of potash and phosphoric acid to magnesia. The normal relation of potash, nitrogen, phosphoric acid, lime, and magnesia in barley straw is given at 100, 50, 30, 40, and 10. The author showed that plants growing in a soil deficient in available plant food of any kind will, in their ash, show a corresponding deficiency, or at least a minimum proportion of the same; and that in many cases the nature of the deficiency manifests itself in the form or development of the plant so nearly as to render chemical analysis unnecessary.

In 1901, Tollens[15] stated *that no definite relation existed between the chemical composition of the ash of plants and the soil in which they were grown.* The stage of growth, the available moisture, the thickness of the stand, the soil, and the fertilizers, are all important factors in producing the variations in the composition of the ash of plants.

Wilfarth and Gcell[16] found that increasing amounts of potash in the soil produced corresponding increased amounts of that ingredient in the plant.

Whitson, Wells, and Vivian,[17] in studying the influence of soil on the protein content of crops, conducted field and pot experiments with corn, oats, barley, rape, and cowpeas. The crops were grown on soils of different degrees of fertility, and nitrogen determinations were made at frequent intervals in the soil and in the crops. In one instance, the nitrogen content of oats grown on soils having the same physical composition, but different degrees of richness in nitrates, was 1.93 per cent on the poorest soil, 2.53 per cent on the medium soil, and 2.66 per cent on

[14]Exp. Sta. Rec. (1902) XIII, p. 637; Abst.
[15]Exp. Sta. Rec. (1901) XII, pp. 207 and 305.
[16]Exp. Sta. Rec. (1902) XIII, p. 1030; Abst.
[17]Wis. Exp. Sta. Report, 1902, p. 192.

the richest soil. In a similar test with corn, the figures were 1.35, 1.59, and 1.80, respectively. The results of the experiments, as a whole, indicated that crops vary greatly in their nitrogen contents at the same stage of development, and that this variation may exist even when crops are making practically equal growth. Under similar seasonal conditions the amount of nitrates in the soil is believed to be the most important factor in causing this variation. The results show a marked relation between the amount of available nitrogen in the soil and the nitrogen content of the plant. The data collected indicated that the richness of the soil determines the yield more than does the climate. The latter determines the length of the growing period and the immunity from early or late frosts and the possibility of bringing the plant to maturity.

Wilfarth and Wimmer[18] observed that a deficiency of nitrogen in the soil caused an increase in the percentage composition of carbohydrates, and a decrease with a deficiency of phosphoric acid.

Soule and Vanatter[19] stated *that a rich soil, or the use of fertilizers, did not seem to increase the protein content of wheat to any appreciable extent.*

Stahl-Schroder[20] found, from a series of experiments with oats on heavy and light soils with different fertilizers, that *the composition of the seed varies considerably with the season* and with the character of the soils, but is not appreciably affected by the variety, or time of planting. He concluded that the analysis of the seeds as a means of determining the assimilable food in soils gives results which are of local value only.

Hall[21] states that *the soil is the least effective environmental factor in producing variations in the composition of wheat,* this statement being based upon data obtained from experiments with oats grown in pots containing six soils of very different characters, which showed that no strict agreement existed between the composition of the ash of the plants and of the soil. The variations in the composition of crops grown in duplicate pots of the same soil were very often greater than between those grown on different soils.

Von Seelhorst and Fresenius[22] observed, from experiments with oats, that the nitrogen content of oat straw was decreased when the amount of moisture applied to the plants was increased.

In 1902, Widtsoe[23] showed that the protein content of wheat increased very markedly as the amount of water applied to the soil decreases. The soil that received 30 inches of water produced wheat containing

[18]Jour. Landw. 51 (1903), p. 129.
[19]Tenn. Sta. Bul. (1903), XVI, No. 4.
[20]Jour. Landw. 52 (1904), 31.
[21]Jour. Soc. of Arts, 1904, 52; No. 2711, 881.
[22]Jour. Landw., 1905, vol. 53, p. 27.
[23]Utah Sta. Bul. 80 (1902), 148.

15.26 per cent of protein; while the wheat produced on soil that received 7.7 inches contained 26.72 per cent. This difference between the wheat grown on non-irrigated land and on land that received 13.79 inches of water was 2.82 per cent.

In 1906, Le Clerc[24] published that the protein content of wheat grown on arid land was higher than when grown on irrigated land. The protein content of wheat, expressed in per cent, grown on irrigated and on adjoining non-irrigated land was 11.1 and 17.7, respectively.

Pingree[25] in studying the effect of various fertilizers upon the composition of oats found that where muriate of potash was applied alone and as part of a complete fertilizer a distinct increase of potash was found in the ash of the plant; also, the application of dissolved phosphate caused an increase of phosphoric acid in the ash of the plant.

Snyder[26] showed that by the proper application of fertilizers the quality of wheat could be improved and thus increase the protein content at least 1 per cent. Some of his results are expressed in Table IV.

TABLE IV.

Protein and ash content of wheat grown on plots receiving different fertilizers.

Kind of fertilizers.	Number of samples.	Protein N x 6.25.	Ash.
Nitrogen	12	13.63	1.58
Potash	12	13.02	1.62
Phosphoric acid	12	12.65	1.73
Complete (N, K_2O, P_2O_5)	12	13.17	1.69
No fertilizer	12	13.04	1.64

It will be noticed that the protein content was highest in the wheat grown on plots receiving a nitrogenous fertilizer, and lowest on plots fertilized only with phosphoric acid.

Stewart and Greaves[27] found that the ash of plants grown in Utah is high, due to the richness of the soil in mineral constituents; and that the nitrogen content of wheat grown on arid land is higher than that of wheat grown on irrigated land, which is in accord with the facts observed by Le Clerc.

[24]Yearbook 1906, U. S. Dept. of Agr., 199.
[25]Penn. State College Report, 1906, 43.
[26]Jour. Am. Chem. Society, 1908, 30: 1, 604.
[27]Utah Sta. Bul. 103 (1908).

EXPERIMENTAL DATA.

In 1905, the California Experiment Station, in collaboration with the Bureau of Plant Industry of the United States Department of Agriculture, undertook an investigation along a similar line, which consisted in growing wheat from the same original seed continuously in each of three localities, viz.: (1) Kansas, Texas, and California; (2) in South Dakota, Kansas, and California.

The crop from the apex of each of these two triangles was sent to each of the other two stations of the same triangle and there grown under the same conditions as the continuously grown seed. Thus, at each station there were three plats all from the same original seed, the seed of the other two plats coming from the other points of the triangle. Two varieties of wheat were thus grown, viz.: Crimean, C. I., 1437 (?), a common wheat of the winter type; and Kubanka, C. I., 1440, a durum variety. The former was grown in California, Kansas, and Texas, the original seed having been grown in Kansas in 1905; the latter in California, Kansas, and South Dakota, the original seed having been grown in South Dakota in 1905. These plantings have been continued until the present year.

Samples were taken each year and analyses made, the detailed analyses as made by Dr. J. A. LeClerc, of the Bureau of Chemistry, United States Department of Agriculture, have been published in Bulletin 128 of that Bureau. The results obtained from analyses of the same samples made at this station are essentially the same as those published by Dr. Le Clerc, and consequently need not be duplicated in the present paper.

The essential conclusions from these analyses are stated by Dr. Le Clerc as follows:

(1) "Wheats of the same variety when grown in the same locality and under the same conditions are, therefore, seen to vary but little in composition, although coming from seed differing widely in physical and chemical characteristics. These results are corroborative of Eckenbrecher's work with barley, and are entirely at variance with Hall's statement that 'each race or variety possesses qualities which are modified only to a slight degree by seed, soil, or climate.'"

(2) "Wheat of any one variety, from any one source, and absolutely alike in chemical and physical characteristics, when grown in different localities, possessing different climatic conditions, yields crops of very widely different appearance and very different in chemical composition."

(3) "The results so far obtained would seem to indicate that the soil

and seed play a relatively small part in influencing the composition of crops."

While the above results seem to indicate that the climatic factor is the principal, if not the only one, affecting the nitrogen content of wheat, yet the experiment was subject to the same sources of error and elements of doubt, as all of the other trials where seed transference had been practiced in the prosecution of studies of this problem, viz., a change of both soil and climate at the same time, thus giving two variable factors, both *climate and soil.*

In 1907, the senior author undertook to neutralize the effect of one of these factors, viz., climate, by securing from Hays, Kansas, a sufficient amount of soil, known to have produced for a number of years high gluten wheat, to make a plat 6 feet long, 3 feet wide, and 3 feet deep. That this Kansas soil was capable of producing a high gluten wheat is evidenced by the protein content of the wheat grown upon it the previous season and forwarded together with the soil. This wheat showed a protein content of 20.06 per cent, as indicated in the table below.

The soil was removed from its original position in the ground in six-inch layers which were shipped in bags to the University Farm at Davis, California, where it was placed in a hole previously prepared to receive it, the soil being placed in said hole in the sequence indicated by the labels, thus bringing the original bottom soil in the corresponding position to that occupied in Kansas, and the same for each other six-inch layer. A second plat was prepared in a similar manner alongside of it by removing the soil from a like area and to the same depth, and replacing the same soil in the hole whence it had been removed. Each of the holes previous to refilling was lined by a rather loose cement lining 1½ inches thick, except the bottom, which was left without lining, the object being to prevent the roots from passing beyond their own area of soil laterally. In placing the soil in the holes, it was dry-tamped to settle it as much as possible, and thus it was allowed to remain until the rain had settled it, after which each plat was cultivated and seeded.

On each of the two plats two types of wheat were grown from 1907 to 1910, inclusive. On one end of each of the plats was placed a high gluten Turkey Red wheat, which grew on the Kansas soil the previous year, and which another table shows carried an unusually high protein content. On the other end of each plat was seeded a low protein California-grown Durum wheat.

By this soil transfer it was intended *to neutralize the effect of climate and have as a variable factor only the soil,* whereas by the seed-transfer method heretofore practiced, there were always two variables and one could never be certain what proportional influence might be due to soil and what to climate in whatever variation occurred in the product.

The writer's idea in using both a low-protein and high-protein grain in this experiment was to secure something of a check, believing that if the soil should prove to be the controlling factor, then the high-gluten Kansas wheat would remain high gluten and fall materially lower upon the California soil, and that the low-gluten California would remain practically the same in the California soil plat and show a marked increase in gluten when grown on the Kansas soil under California climate. The results set forth in the table do not show that the soil has produced any marked effect of this kind.

The Soils.—The two soils used in this experiment show a marked contrast in appearance and in texture. The California soil is the type which is quite general in the Sacramento Valley, and known as a gray silt loam. It has been cropped to grain for many years—at least forty—and is still producing under good culture heavy crops. It is quite inclined to bake and crust if wet upon top and then allowed to dry. It is more inclined to do this than is the soil from Kansas. The Kansas soil is black in color, and carries markedly less sand than the California soil, as will be seen from the subjoined mechanical analysis, this difference in sand being compensated by a corresponding increase in silt, while the clay and fine silt content of the two types is essentially the same. This type would undoubtedly be classed as a silt loam, although it exhibits essentially different properties than the California soil.

The details of the mechanical analysis are shown in the following table:

TABLE V.

Mechanical constituents of soils from Davis and Kansas.

Diameters of sediments.		Percentage, Davis.	Composition, Kansas.
mm.	Clay	19.12	18.26
to .016	Fine silt	40.93	44.56
.016 to .025		3.35	3.20
.025 to .036	Silt	1.34	11.01
.036 to .047		7.75	12.27
.047 to .072		8.78	7.49
.072 to .12	Sand	8.10	1.19
.12 to .16		3.30	.72
.16 to .30		4.15	.46
.30 to .50		3.07	.76
		99.89	99.92
	Summary.		
	Clay	19.12	18.26
	Fine silt	44.28	44.76
	Silt	17.87	30.77
	Sand	18.62	3.13
		99.89	99.92

The chemical composition of the soils as represented by one-foot samples is shown in the following table, the analyses having been made according to so-called official method:

TABLE VI.

Comparison of soils in soil transference.

	First foot.		Second foot.		Third foot.	
	California.	Kansas.	California.	Kansas.	California.	Kansas.
Insoluble matter	76.04	79.79	76.83	80.19	77.80	79.80
Soluble matter	23.96	20.21	23.17	19.81	22.20	20.20
Iron and alumina	15.43	10.57	13.84	10.67	13.40	10.85
Calcium oxid	.85	.88	1.43	.73	.97	1.26
Magnesium oxid	.76	1.22	1.74	2.40	1.58	2.25
Sodium oxid	.14	.22	.27	.44	.25	.33
Potassium oxid	.52	.66	.49	.75	.45	.87
Sulfuric acid	.13	.15	.08	.05	.07	.08
Phosphoric acid	.34	.30	.32	.36	.34	.41
Volatile matter	5.87	6.50	4.83	4.47	5.30	4.11
Total soluble matter	24.04	20.50	23.00	19.87	22.36	20.16
Total nitrogen in soil	.100	.163	.085	.057	.058	.034
Humus in soil	1.54	1.54	1.24	.707	1.70	1.12
Nitrogen in humus	.07	.10	.03	.062	.052	.025

In each foot the total soluble matter in the California soil exceeds that of the Kansas soil. The principal difference in the two appears in the iron-alumina content.

In the top foot, of the essential elements of plant food there appears practically no difference in either lime, potash or phosphoric acid. Both soils appear well supplied with all three of these compounds, and this similarity of composition also extends to the humus, which is identical in amount in the two soils, and to the nitrogen of the humus.

The same general relation holds with reference to the soluble portion of the second foot, the California soil showing 23.17 per cent, as against 19.81 per cent for the Kansas soil. The same general difference holds, also, with regard to the iron-alumina content, but in the matter of lime there is a marked increase in the California soil and a slight decrease in the Kansas soil. There is a distinct increase in the second foot of both soils, but no essential change or difference in phosphoric acid content. The humus content quite markedly decreases in both soils, the California soil showing about one sixth less and the Kansas soil less than one half as much. This same difference shows in the total nitrogen in the soil, but the nitrogen in the humus appears to be higher in the Kansas soil which is also true of the first foot of soil.

In the third foot the Kansas soil shows the larger per cent of lime, also of potash and phosphoric acid, while the total nitrogen in the soil still is the higher in the California soil. In both the California and the Kansas soils there appears more humus in the third foot than in the second foot, but there is still less in the Kansas than in the California soil, although the nitrogen in the humus has decreased by about one half and that of the home soil increased.

Thus, we may sum up the soil difference as follows: A distinctly larger amount of soluble matter in the California soil; the top foot in the two soils essentially the same; in the second foot about twice as much lime in the California as in the Kansas soil; about two sevenths more potash in the Kansas soil than in the California. The California soil carries a distinctly larger amount of soluble matter, but otherwise is essentially the same, except for total nitrogen, in which the Kansas soil exceeds by about one third. It carries double the lime in the second foot, but not only decreases in amount in the third foot, but falls well below the Kansas soil. It carries less potash, but in phosphoric acid does not differ materially. In total nitrogen it exceeds that of Kansas, as it does in humus content.

In the matter of nitrogen the Kansas soil is the better supplied in the top foot, but otherwise the advantage lies with the California soil. Inasmuch as the bulk of the feeding roots of the plant are in the second foot, the California soils seems to have an advantage and this is quite significant when considered with the results obtained from the analysis of the grain grown on these two plots.

FIELD NOTES.

Field notes and observations for the two seasons here reported were made as follows:

TABLE VII.

Showing field notes on soil exchange wheats. (Exp. D-5.)

	Season 1907-8.				Season 1908-9.			
	Kubanka Low gluten.		Turkey Red—High gluten.		Velvet Don—Low gluten.		Turkey Red—High gluten.	
	Davis soil.	Kansas soil.	Davis soil.	Kansas soil.	1063 Davis soil.	1062 Kansas soil.	Davis soil.	Kansas soil.
Date planted	January 27	January 27	January 27	January 27	December 17	December 17	December 17	December 17
Came up	February 16	February 16	February 16	February 16	January 6	January 6	January 6	January 6
Headed	May 14	May 16	May 7	May 6	May 6	May 5	May 14	May 13
Uniformity of heading	80	75	60	80	90	95	85	90
Bloomed	May 17	May 19	June 21	June 10				
Ripened	June 26	June 28	July 16	July 16	June 24	June 22	June 26	June 24
Harvested	June 29	June 29	July 17	July 17	June 24	June 24	June 26	June 24
Number days to maturity	132	134	152	152	169	167	171	169

TABLE VIII.

Analysis of wheat grown on soil exchange plats, Davis, California. (*Exp. D-5.*)

	Season of 1907-08.						Season of 1908-09.					
	Kubanka Durum—Low gluten.			Turkey Red—High gluten.			Velvet Don—Low gluten.			Turkey Red—High gluten.		
	Original Lab. No. 1071	California soil No. 1072	Kansas soil No. 1073	Original No. 981	California soil No. 981 A-C	Kansas soil No. 981 A-K	Original No. 1061	California soil No. 1063	Kansas soil No. 1062	Original No. 981	California soil No. 981 B-C	Kansas soil No. 981 B-K
Total protein	10.56	15.11	15.07	20.06	18.29	18.02	9.43	13.23	12.95	20.06	15.07	14.32
Ash	2.05	1.88	1.65	2.47	-------	2.21	2.02	1.74	1.65	2.47	2.02	1.88
Fat	2.84	2.30	2.53	2.09	-------	1.97	2.50	2.23	2.41	2.09	1.87	2.08
Fiber	3.43	3.25	3.37	2.24	-------	2.15	3.02	3.54	3.32	2.24	2.68	2.31
Pentosans	6.60	7.63	-------	7.70	-------	-------	7.80	7.00	7.76	7.70	7.64	7.16
Sugars	2.64	3.93	-------	-------	-------	-------	3.11	3.54	3.10	-------	4.31	4.31
Alcohol; soluble nitrogen	.68	1.18	1.23	1.44	1.14	.98	.78	.95	.98	1.44	1.14	1.17
Salt; soluble nitrogen	.69	.62	.73	.83	-------	.70	.47	.62	.55	.83	.72	.64
Percentage typical kernels	19.54	98.00	99.30	100.00	100.00	100.00	82.01	79.60	71.8	100.00	99.10	98.78
Percentage starchy kernels	80.46	2.00	.70	-------	-------	-------	17.99	20.40	28.2	-------	.90	1.22
Kernels in 10 grams	220	203	189	444*	363	340	239	227	231	444	266	262
Days to mature	-------	131	133	-------	151	151	-------	169	167	-------	171	169

*Slightly pinched.

In the season of 1907-08 it will be noted that the Durum wheat (Kubanka) headed two days later on the Kansas soil than on the home soil, and that it also matured two days earlier on the Davis soil. In the case of the Turkey Red grain, if there was any difference in rapidity of growth, it was in favor of the Davis soil; but the grain matured in both soils in the same time, viz., 152 days.* These plats were apparently under as uniform a condition in the field as it was possible to make them.

Field notes for the season of 1908-09 do not show that the conditions of growth were as uniform as in the preceding season. During this season the rate of growth was slightly greater upon the Kansas soil. On May 5th, the Turkey Red wheat was 2 feet 6 inches tall on the Kansas soil, but only 2 feet 3 inches on the Davis soil, and a similar difference held for the Durum wheat also. The mass of growth was also somewhat heavier on the Kansas soil plat.

At harvest the Durum wheat gave the following yield upon each of the plats:

	Davis soil.		Kansas soil.	
	Number of plants.	Weight.	Number of plants.	Weight.
Border plants	35	2 lb. 11 oz.	29	3 lb. 3 oz.
Interior plants	45	3 lb. 11 oz.	52	5 lb. 8 oz.
Total	80	6 lb. 6 oz.	81	8 lb. 11 oz.

The Turkey Red wheat was not weighed.

The results of analyses for these plots are expressed in Table VIII.

VARIATIONS IN NITROGEN CONTENT.

Since the nitrogenous ingredients of wheat are of the chief importance, the principal attention will be directed toward these in the discussion. In the case of the low-protein original, each of the soil plats produced in 1907-08 grain of higher protein content than the original by about 4.5 per cent, thus indicating a very marked seasonal influence. In this connection it should be stated that the entire grain crop of the Sacramento Valley in that season showed a higher gluten content than it did in the preceding season, and this becomes quite significant when considered with the other data bearing on this question. Comparing the grain produced upon the two types of soil, it is easily seen that there is no practical difference in total protein between the two lots, showing as they do 15.14 per cent and 15.07 per cent, respectively, for California

*This time is reckoned from the date of coming up to the date of ripening.

and Kansas soils, these soils being under the same climatic conditions, the very slight difference being entirely within the range of analytical error. What slight difference there is, however, is in favor of the California soil. If we turn to the trial with the high-protein original (981) grown in Kansas, it is clear that, while under the California climate there has been a lowering of the total protein on this soil by about 2 per cent, yet *this has taken place both on the California plat and the Kansas plat by practically the same amount, there being only a difference of 0.27 per cent and this slight difference in favor of the California soil.* This difference, however, is too small to be attributed with any certainty to any inherent difference in soil composition.

In the season of 1908-09 both high and low gluten types of wheat were grown on these plats as in the preceding year. The low-gluten Durum original was even lower than that of the preceding year, carrying but 9.43 per cent protein. The same conditions as in 1907-08 are again shown on these plats, viz., a higher development of total protein in the product in each of the plats than in the original used, the increase being about 3.50 per cent, but, *as between the two plats, there was no practical difference,* 13.23 per cent and 12.95 per cent for California and Kansas soils, respectively, or but 0.28 per cent. That of the preceding year was 0.27 per cent. In both years the slight difference was in favor of the California soil.

The high-protein original (981) used for this season was the same as that of the preceding season, and again there was a marked lowering of the protein content under the California condition. There was a greater difference in the case of this wheat than in the preceding trials, the California soil plat showing 15.07 per cent total protein and the Kansas plat 14.32 per cent; in other words, a difference of .70 per cent, again in favor of the California soil.

If now we turn attention to the alcohol-soluble nitrogen content, it will be seen that there is the same general change between the original used and the resulting product, viz., a well-defined lowering of the nitrogen in the case of the low protein type, yet, as between the two plats, such difference as occurs is, in general, in favor of the Kansas soil. In the case of the grain produced from the low-protein original, the two plats showed an essential difference, 1.18 per cent and 1.23 per cent, respectively, for California and Kansas soils. Such small difference as occurs, viz., .06 per cent, is in this case in favor of the California soil, and in each of the succeeding years, including 1909-10, this difference in alcohol-soluble nitrogen is very slight, but uniformly runs in favor of the Kansas soil. However, *the differences that occur are probably too small to be attributed to any difference in the soil characteristics, and might well come within the limits of analytical error.*

On the other hand, it is interesting to note that in the case of the salt-

soluble nitrogen such small differences as appear from the analyses, with the exception of the first season, have been in favor of the Kansas soil, but here again, as in the preceding, there is altogether too slight a difference to attribute it to the soil without a much longer series of tests.

The other constituents and the physical appearance of the grain produced on the two plats were practically identical, although the fat content has been uniformly in favor of the Kansas soil plat by about 0.2 per cent.

From these results it would appear that a normal soil has little if any influence upon the nitrogen content of the wheat kernel, but that climatic factors are the controlling ones. The experiment has been of such short duration, however, that it needs further corroboration before it can be accepted absolutely.

THE TRIANGULAR SOIL EXCHANGE EXPERIMENT.

In 1908, a year later than the experiments described in the preceding pages, a second set of soil plats were secured in coöperation with the United States Department of Agriculture, in order to broaden the scope of the experiments. These plats serve a very useful purpose as a check upon the results secured from the original plats, as well as furnishing results in an independent experiment. The Kansas soil used in the second series is from the same place and is of the same physical characteristic as that secured for the first series, as is also the Davis soil and the undisturbed check plat used in this experiment. The third plat is of soil from the Arlington farm of the United States Department of Agriculture in Maryland, and of a distinctly different type.

In this experiment the arrangement is somewhat different than in the first series, and consisted in transferring a sufficient quantity of soil from each of three experiment stations located in California, Kansas, and Maryland, to each of the others, viz., a plot, 5 feet square and 3 feet deep, of California soil was sent to each of the other two stations, and in exactly the same way plots of Kansas soil were sent to California and Maryland, and plots of Maryland soil were sent to California and Kansas. Wheat from the same original seed, supplied by the Department of Agriculture, was grown in these different soils at the three stations to ascertain the effect of the soil on the composition of the crop. There were thus four plots of soil at each station used in the experiment, two were imported soil and the other two home soil, one of which had been disturbed as were the others in shipping, and the other was undisturbed home soil. Under these conditions all the disturbing factors save those due to the soils alone were eliminated.

It must be stated that a supposition is made in the premises, namely, that the plants do not assimilate any of the constituent elements of plant food contained in the soil below the third foot. It is believed, however,

that the crop as a whole obtained its food from the food constituents contained in the first three feet of soil, although as a matter of fact in the Kansas and the Davis soil plats the wheat roots did extend below the third foot.

Observations were made to ascertain the depth the roots penetrated the soil, and it was found that in one or two instances the roots of the plants grown on the California and Kansas soil reached a depth of 42 inches. On the Maryland soil plat no plant roots were found to go beyond the first three feet. It is firmly believed that the crops as a whole obtained their food from the food constituents contained in the first three feet of soil.

It was thought at the beginning of the experiment that a cement block or metal sheet under the first three feet of soil, to prevent the roots from going to a greater depth, would cause other abnormal conditions, such as a drying-out of the soil, which would, in the end, give results no more reliable and would not be comparable with the check plat. Each plat of soil was, however, walled with California redwood.

The California soil used in the experiment is described as a Sacramento silt loam. The Kansas soil is a dark heavy loam, while the soil from Maryland is a light yellow clay. The three soils are not lacking in any of the principal plant-food constituents and have the composition given in the table below:

TABLE IX.

Percentage composition of soils.

Foot.	Nitrogen.	Phosphoric acid.	Potash.	Sulphuric acid.	Lime.	Magnesia.
California Soil.						
First	.118	.161	.49	.121	.704	.703
Second	.074	.127	.473	.053	.621	1.69
Third	.058	.124	.462	.046	.683	1.48
Average	.083	.137	.475	.073	.669	1.29
Maryland Soil.						
First	.111	.114	.342	.13	.191	.42
Second	.076	.127	.278	.111	.222	4.75
Third	.042	.111	.450	.053	.204	4.72
Average	.076	.117	.357	.098	.205	3.297
Kansas Soil.						
First	.174	.160	.602	.14	.89	1.301
Second	.121	.173	.783	.08	.796	2.29
Third	.040	.165	.902	.09	1.69	2.18
Average	.111	.166	.762	.10	1.125	1.92

NOTE.—The "Official Methods" recorded in Bulletin No. 107 (revised) of the Bureau of Chemistry, U. S. Dept. of Agriculture, were followed in making the analyses recorded in this paper.

During the first season of the experiment, 1908-09, Turkey wheat (No. 1571) was grown on the four plats of soil. This is a common winter wheat, and was supplied by the United States Department of Agriculture. Instead of using the same Turkey seed in the second season's experiment, a high protein wheat, Crimean, a common winter wheat, was used. The results obtained from these two varieties of wheat during the two seasons are given in the following table:

TABLE X.

Percentage composition of original seed and wheat produced from it on the various soil plots.

No.	Plot.	Nitrogen.	Ash.	Phosphoric acid.	Potash.	Sulphuric acid.	Lime.
	FIRST SEASON—1908-1909.						
1067	Check	2.74	1.60	.842	.55	.839	.067
1066	California	2.86	1.45	.799	.529	.737	.113
1065	Maryland	2.11	1.68	1.196	.673	.603	.150
1064	Kansas	2.07	1.47	.771	.537	.544	.157
	ORIGINAL TURKEY SEED.*						
-----	Original	2.35	1.86	0.87	--------	0.62	0.10
	SECOND SEASON—1909-1910.						
1078	Check	2.36	1.80	.850	.567	.896	.087
1077	California	2.50	1.77	.788	.602	.687	.175
1076	Maryland	3.06	2.40	1.000	.703	.984	.110
1075	Kansas	1.97	1.68	.875	.569	.611	.197
	ORIGINAL CRIMEAN SEED.						
1074	Original	3.06	1.71	.861	.604	.894	.090

*There was not enough of this sample available to make a determination of the mineral constituents. The figures here given were furnished by Dr. J. A. Le Clerc, of the Bureau of Chemistry.

TABLE XI.

Showing approximate analysis of wheats grown on triangular soil. Exchange plats 1908-10.

	Season 1908-9.					Season 1909-10.				
	Original C. I. No. ----	Check California soil, undisturbed. No. 1067	California soil. No. 1066A	Kansas soil. No. 1064A	Maryland soil. No. 1065	Original C. I. No. 1571. No. 1074	Check California soil, undisturbed. No. 1078	California soil. No. 1077	Kansas soil. No. 1075	Maryland soil. No. 1076
Total protein	13.40	15.61	16.33	11.80	13.20	17.18	13.45	14.27	11.23	17.44
Ash	1.86	1.90	1.74	1.64	1.71	1.96	2.15	2.11	1.85	2.19
Fat	----	2.76	2.20	2.59	2.06	1.90	1.86	1.82	1.77	1.73
Fiber	----	3.40	3.33	3.45	3.44	2.26	2.36	2.69	3.02	2.92
Alcohol—Soluble nitrogen	----	1.22	1.59	.84	.92	1.35	.91	1.01	.76	1.19
Salt—Soluble nitrogen	----	.62	.48	.50	.71	----	----	----	----	----
Percentage of typical kernels	----	99.10	99.82	79.75	97.47	100.	90.1	100.	64.7	100.
Percentage of starchy kernels	----	.90	.18	20.25	2.53	----	.6	----	35.3	----
Kernels in 10 grams	----	----	303	269	356	335	347	374	300	474
Days to mature	----	272	288	208	231	299	238	253	204	317

VARIATION IN CHEMICAL COMPOSITION OF GRAIN.

The original Crimean seed which had been produced on Kansas soil in Kansas and containing a high nitrogen content, 3.04 per cent, when grown on Kansas soil in California fell to 1.91 per cent, a decrease of 1.13 per cent. The nitrogen content of the same seed remained almost exactly the same when grown on Maryland soil in California, and decreased to 2.4 per cent when grown on California soil in California. In this connection it will be noticed that the nitrogen content of the Kansas soil was the highest, while the Maryland soil contained the least amount of nitrogen. The grain produced on the Maryland soil was pinched and the yield was low, probably due to the inability of that soil to hold moisture. This fact accounts for the high nitrogen content of the grain produced on the Maryland soil. The data shows no regularity in the nitrogen content and no relation between the amount of that element in the seed and in the soil.

With the exception of the wheat grown on Maryland soil the amount of ash in the grain is fairly uniform. It will also be noticed that the potash and phosphoric acid content of the grain grown on Maryland soil during both seasons was highest, and with one exception, namely, the wheat grown on California soil, the sulphuric acid content was the highest and the phosphoric acid and potash content of the Maryland soil the lowest of the three soils. The lime-magnesia ratio of the Maryland soil is as 1:16, and it may be that this large amount of magnesium is responsible for the assimilation of the other constituents to a greater degree.

The ash and nitrogen content of the grain grown on both plots of California soil are practically the same, but the variation occurring in the other constituents is almost as great as that occurring in the grain produced on the other soils. This indicates that a disturbance of the soil to a depth lower than the ordinary depth of cultivation has a marked effect on the assimilation by the plant of the mineral elements contained therein. With such a variation occurring in the mineral constituents of the grain grown on the same soil, it would be unsafe to assume that the amount of food ingredients assimilated by the plant is in direct proportion to the available materials present in the soil.

The lime content of the Kansas soil was highest and that substance was present in a greater quantity in the grain grown on that soil. The ratio of phosphoric acid to potash is higher in the crop than in the soil. The same fact is also true of the nitrogen-phosphoric acid and nitrogen-potash ratios.

PHYSICAL APPEARANCE OF GRAIN.

A very notable difference occurs in the appearance of the grain. During the first season the grain grown on both plats of California soil, the check plat and the disturbed soil plat, was practically the same, well formed, plump kernels of a typical amber. Very few starchy kernels were noticed in either of the lots. The individual kernels were somewhat larger in the grain produced on the check plat, 285 kernels weighing 10 grams, as against 303 kernels from the disturbed soil plat. The seed produced on the Maryland soil was pinched, the grains were much smaller than those mentioned above, 356 weighing 10 grams. A few more starchy grains were observed, although the percentage was below 5 per cent.

The results of the second season showed more starchy berries (as high as 8 per cent) in the seed grown on the check plat than that grown on the other California soil plat. And, as in the previous season, the individual kernels were larger, 347 grains weighing 10 grams as compared with 374 grains. The seed from the disturbed plat was plump, a typical amber, and has high milling qualities. It contained practically no starchy grains. Again the grain on the Maryland soil was pinched, the berries were small, 474 weighing 10 grams, and practically no starchy grains were present. The seed produced on the Kansas soil contained as high as 60 per cent of starchy grains. The berries were heavier than the others, 300 weighing 10 grams. The original Crimean seed contained no starchy berries, and 335 kernels weighed 10 grams.

It is also interesting to note the amount of nitrogen present in the large and small berries. One thousand grains of the seed produced the first season on the check plat, the disturbed plat of California soil, the Maryland soil plat, and the Kansas soil plat weighed 37.4, 34.8, 27.4, and 37.1, respectively. The percentage of nitrogen in the same grain was 2.77, 2.85, 2.11, and 2.06, respectively. Expressing the amount of nitrogen in grams per 1,000 kernels we would get 1.04, .99, .58, and .76, respectively. From this it will be observed, contrary to the rule, that the smaller grains produced on the Maryland soil contained much less nitrogen than the larger grains. One thousand grains of the seed grown on the same plats the following season weighed 28.6, 29.6, 22.6, and 36.1 grams, respectively. The percentage of nitrogen was 2.48, 2.33, 3.02, and 1.91, respectively; or again representing this as grams of nitrogen per 1,000 kernels it would be .71, .69, .68, .69, respectively. It is clearly seen in this case that the different seeds, although varying considerably in size, contain practically the same quantity of nitrogen. The weight of the different constituents in 1,000 kernels is summarized in the following table:

TABLE XII.

Weight in grams per 1,000 kernels.

SEASON 1908-1909.

Plot.	Weight of 1,000 kernels	Grams nitrogen per 1,000 kernels	Grams phosphoric acid per 1,000 kernels	Grams potash per 1,000 kernels	Grams sulphuric acid per 1,000 kernels	Grams lime per 1,000 kernels
Check	37.38	1.04	.32	.21	.31	.025
California	34.77	.99	.28	.18	.26	.039
Maryland	27.42	.58	.33	.18	.17	.041
Kansas	37.1	.76	.29	.20	.20	.058

SEASON 1909-1910.

Check	29.71	.71	.25	.17	.26	.026
California	28.73	.70	.23	.17	.20	.050
Maryland	22.69	.69	.23	.16	.22	.025
Kansas	36.11	.69	.21	.20	.22	.071

Conclusions.—It must be said that the results so far obtained do not shed as much light upon the primary question as to the influence of the soil nitrogen upon the nitrogen content of the wheat as could be desired, possibly on account of the short duration of the experiment. It is evident, however, that in neither of the series of trials has the grain carrying the larger nitrogen content been obtained from the soil plat having the heaviest total nitrogen content. In the light of the present data it seems quite certain that the soil nitrogen content has very little, if any, direct influence upon the nitrogen content of grain grown upon such soil, and that some climatic factor is sufficient to entirely overshadow the soil factor. This is entirely in harmony with the work of Dr. Le Clerc previously reviewed, and also with the well known wide fluctuation of the nitrogen content of wheat from season to season, although the grain be grown upon the same soil. It may be that certain physical factors, enabling the soil to hold moisture better at certain periods of the plant's growth are responsible for the difference, but of this we have no data so far as these plats are concerned.

The results also show that a chemical analysis of a soil by the ten-hour hydrochloric acid (sp. gr. 1.115) digestion method reveals no definite relation between the chemical composition of the soil and the crop.

Further, it appears that the nitrogen content of an original seed when grown elsewhere than in a climate within which it has been acclimated, has little or no influence upon its progeny, and that even though it be acclimated still some seasonal climatic factor is sufficient to either lower the nitrogen content of a high-gluten wheat or raise the nitrogen content of a low-gluten original.

ADDENDA.

Since the preparation of the previous matter, analyses have been made of the product of the 1911 crop from the triangular soil exchange plats. For the season of 1911, the original for each of the plats and the general check consisted of the seed produced on the same plat the preceding season.

The results are stated below:

TABLE XIII.

Showing analyses of wheats from triangular soil exchange plats 1911. Interior plants.

	Check.		California.		Kansas.		Maryland.	
	Original.	1911 crop.	Original.	1911 crop.	Original.	1911 crop.	Original	1911 crop.
Total protein	13.45	12.04	14.27	10.56	11.23	9.61	17.44	13.20
Ash	2.15	1.60	2.11	1.88	1.85	1.76	2.19	1.78
Alcohol—Soluble nitrogen	.91	.93	1.01	.76	.76	.70	1.19	.80
Salt—Soluble nitrogen	.51	.50	.54	.45	.46	.47	.57	.50
Percentage typical kernels	90.40	88.80	100.00	50.8	64.7	46.0	100.00	100.00
Percentage starchy kernels	.6	11.2	------	49.2	35.3	54.0	------	-----
Kernels in 10 grams	374	261	374	289	204	265	474	425

TABLE XIV.

Showing analyses of wheats from triangular soil exchange plats 1911. Exterior plants.

	Check.		California.		Kansas.		Maryland.	
	Original.	1911 crop.	Original.	1911 crop.	Original.	1911 crop.	Original.	1911 crop.
Total protein	13.45	12.04	14.27	11.60	11.23	12.12	17.44	12.52
Ash	2.15	1.60	2.11	1.89	1.85	1.80	2.19	1.72
Alcohol—Soluble nitrogen	.91	.93	1.01	.82	.76	.90	1.19	.72
Salt—Soluble nitrogen	.51	.50	.54	.51	.46	.56	.57	.57
Percentage typical kernels	90.4	88.8	100.00	61.3	64.7	82.4	100.00	96.8
Percentage starchy kernels	.6	11.2	------	38.7	35.3	17.6	------	3.2
Kernels in 10 grams	347	261	374	289	204	269	474	269

As in the previous two seasons, the grain produced on the Maryland soil was pinched and the kernels were small, which fact again renders this product not comparable with the others.

Showing relative yield from the triangular soil exchange plats 1911.

The ash content of the produce of the check plat is markedly low when compared with the others, which are very uniform in ash content. The selected interior product of each of the California and Kansas plats shows a marked uniformity in the nitrogen and ash content as well as in the number of kernels in 10 grams, and the percentage of starchy and typical kernels. They show, however, less nitrogen than the grain from the check plat.

On comparing the chemical characteristics of the exterior plants it will be noticed that the figures in all of the columns for the grain from the check and Kansas plats agree tolerably well.

The most striking point brought out by these last figures, is the difference in composition and appearance of the grain produced on the same soil, viz.: the check plat and the other California soil plat. There is a greater difference between these two products than exists between the others or between these and the others. This difference, particularly with respect to the nitrogen, is not nearly so great, however, as that brought out by Le Clerc (*loc. cit.*) from his experiments in which both soil and climate were variable factors. It does, however, indicate that some other factors pertinent to the physical or biological conditions of the soil play an important rôle since we have, in our own experiment, only one variable factor, viz.: the soil. Moreover, the slight variations occurring in the chemical characteristics in these experiments, being considerably less than those observed by Le Clerc, adds strongly to the belief that the climatic factor is the chief one in producing changes in the chemical composition of wheat.

STATION PUBLICATIONS AVAILABLE FOR DISTRIBUTION.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-03.
1904. Twenty-second Report of the Agricultural Experiment Station for 1903-04.

BULLETINS.

Reprint. Endurance of Drought in Soils of the Arid Region.
No. 128. Nature, Value, and Utilization of Alkali Lands, and Tolerance of Alkali. (Revised and Reprint, 1905.)
133. Tolerance of Alkali by Various cultures.
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186. The Oidium of the Vine.
No. 187. Commercial Fertilizers. (January, 1907.)
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198. The Grape Leaf-Hopper.
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201. Commercial Fertilizers. (June, 1908.)
202. Commercial Fertilizers. (December, 1908.)
203. Report of the Plant Pathologist to July 1, 1909.
204. The Dairy Cow's Record and the Stable.
205. Commercial Fertilizers. (December, 1909.)
206. Commercial Fertilizers. (June, 1910.)
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UNIVERSITY OF CALIFORNIA PUBLICATIONS

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FUMIGATION STUDIES No. 5

DOSAGE TABLES

By C. W. WOODWORTH

BULLETIN No. 220

(Berkeley, Cal., July, 1911)

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FUMIGATION STUDIES No. 5.

DOSAGE TABLES.

By C. W. Woodworth.

The study of the leakage of fumigation tents has now reached the point where it becomes possible to present tables of dosage so calculated that there may be approximately equal killing power under tents of varying degrees of leakage.

A recent publication[1] states "Most of the ducks and drills now used in California are about equally gas-tight," but actual measurements of the leakage of the fumigation tents operating in the orchards in Orange and Los Angeles counties have shown wide variation in this respect and the same tent is much tighter moist nights than on dry nights, indeed, practical fumigators have long realized that it was impossible to secure a good killing of scale on dry nights.

If it were possible to figure on the tent always maintaining the same degree of leakage, a single dosage schedule would be sufficient, though different tents might not require the same schedule. The fact is, however, that variation in leakage proves to be the most important factor to be considered, and as long as it is neglected will result in errors in dosage several times greater than those that are liable to occur through mistakes in guessing the size of a tree, which heretofore has been supposed to be the most important cause of irregularity in results secured.

Only the very wide margin of safety, permitting the use of gas very much stronger than necessary to kill the scale insect, has enabled fumigators to obtain fairly uniform results, notwithstanding the variation in loss of gas through the tent. When trees are dosed according to leakage it will probably be found safe to materially economize in the amount of chemicals used. In these tables, however, the full strength of chemicals now commonly used is indicated, since there must be considerable more data secured before it will be safe to recommend a material reduction. The use of these tables, therefore, simply insures greater uniformity in results.

The true basis for any system of dosage is the volume of the spaces enclosed by the tent, that is, the cubic contents. All the older tables

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The early studies of this series are as follows:
1. Bulletin 122, Orchard Fumigation.
2. Bulletin 152, Fumigation Dosage, 1903.
3. Circular 11, Fumigation Practice, 1904.
4. Circular 50, Fumigation Scheduling, 1910.

[1]Bulletin 90, U. S. Division of Entomology, "Fumigation of Citrus Trees," R. S. Woglum, p. 53.

of dosage[2] are based solely upon the volume. Eight years ago we suggested (Bulletin 152) the use of the surface area of the tent as a basis for dosage, showing that this corresponds very much nearer with the actual practice of fumigators. It was understood at the time that such a calculation was fundamentally wrong, but since the data was not at hand for determining the leakage factor; that is, the amount the dose must be increased to allow for the leakage, it was suggested as a rough approximation.

The area basis has been adopted by all subsequent writers on fumigation and has been generally supposed to correctly allow for leakage[3]. If this were true differences of leakage could be provided for by simply making a proportionate increase or decrease of dose. On a volume basis one tent twice as large in each dimension as another would require eight times the dose, while on an area basis it would require only four times. Now any amount of proportionate increase of dose for a tighter tent would still retain the ratio 1 to 4 instead of approaching 1 to 8, as it should.

From these considerations one will readily appreciate that an area basis of calculation will not produce an accurate table of dosage for any degree of leakage whatever, and can be an approximation for only one definite degree of leakage.

The full explanation of the method of calculation of the leakage factor and the detail of the experiments, upon which it is based will be given in another bulletin. For the present purpose it will only be necessary to explain enough to permit intelligent use of the tables.

LEAKAGE.

In the experimental work the tents were tested double thick, that is, a fold of the cloth was placed in the apparatus. The reason for this was that by doing so a test could be made at any point over the surface as easily as at the edge. The average of over 5,000 determinations of the leakage of tents in operation was, when calculated for a single thickness of the cloth, approximately .25 per cent. With this leakage the gas will escape through a square foot of the average tent material at the same rate it would through a hole about $\frac{1}{3}$ of a square inch in size. Some tents were found in operation with more than twice this leakage and others were less than half as leaky. The common range was from .10 to .40 per cent. The tables below have been calculated for .10 per cent.

[2]Morse, Bulletin 71, Calif. Agr. Exp. Station, 1887.
Coquillett, Report for 1887, U. S. Dept. of Agr. pp. 123-142, 1888.
Coquillett, Insect Life, Vol. II, pp. 202-207, 1889.
Woodworth, Bulletin 115, Calif. Agr. Exp. Station, 1896.
Johnson, Bulletin 57, Maryland Agr. Exp. Station, pp. 72-95, 1898.
Woodworth, Bulletin 122, Calif. Agr. Exp. Station, 1899.

[3]Woglum, Bulletin 79, U. S. Division of Entomology, 1909, p. 47, determined "leakage surface" by dividing the area by the volume and the dose by multiplying this by the volume; the product is, of course, only the area.

.15 per cent, .20 per cent, .25 per cent, .30 per cent, .35 per cent, and .40 per cent, and the leakage meters designated for determining the leakage are graduated into these degrees. A full account of the construction and use of leakage meters is given in another bulletin.

The determination of the leakage of the tent must come to be a very important part of the process of fumigation. There seems to be no way of estimating the leakage with sufficient accuracy except by actually measuring it. We may know that one tent is tighter than another, and that any tent holds the gas best when the air is damp, but the only way to make full use of this knowledge is to have it in a definite form so as to choose the correct system of dosage. With the new apparatus now available the measuring of leakage is a very simple and rapid process, and there is no reason why every fumigating outfit should not be provided with a leakage meter.

A result sure to follow the adoption of the rational basis for dosage now advocated will be the elimination of the more leaky tents. Such tents will either be made tight by treatment or discarded altogether, because the doses by this system will be so large that the economy of so doing will be very evident.

In the selection of new tents the saving that will follow the adoption of the tighter material will be capable of being accurately estimated and the question of its economy readily determined.

THE DOSE.

After measuring the leakage of the tent, the next question will be determining the dose which will correspond with the degree of leakage. Evidently there are three factors in this problem. First, the insect to be killed; second, the size of the tent, and third, the leakage of the tent.

The insect, as far as our present knowledge goes, has a constant effect on the dose, that is, if the dose is determined for the purple scale, that for the black scale is always a certain fraction of the purple scale dose. This relationship has never been accurately tested out, but is probably true, and has been uniformly accepted as true by all who have had to do with fumigation. In the tables given below the relationship assumed as the correct ratio of dosage for the black, red and purple scales, respectively, is $4:5\frac{3}{4}:7\frac{1}{2}$.

The size of the tree, as pointed out above, affects the dosage differently according to the leakage. With an absolutely tight tent the dose should correspond strictly with the size, but as tents average in the field, the universal practice is to vary the dose very much less rapidly than the size or volume basis of calculation would provide. This factor is, therefore, incapable of adequate treatment without a knowledge of the leakage.

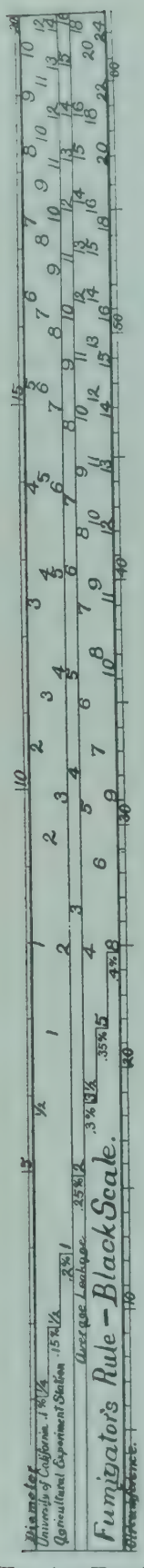


FIG. 1.—Fumigator's rule, leakage basis.

The determination of the size is very fully discussed in Circular 50 and a new rapid method described below.

The leakage is very easily determined, but to determine its relationship to the dose requires a very complicated mathematical formula. This much, however, can be readily appreciated, that given trees of equal leakage and different size will differ in dose, and if equal in size but different in leakage they also differ in dose, it is evident that the same dose may apply to two trees of different sizes. provided they have a certain definite difference of leakage.

FUMIGATION RULE.

The impossibility of briefly describing the effect of the leakage upon the dose is shown by Fig. 1, where the doses corresponding with trees of different sizes and with different degrees of leakage are given.

The effect of the leakage upon the dose in the case of any particular size is shown by the numbers read crosswise of the rule. The smaller the tree the greater the effect of the leakage upon the dose. This is due to the larger amount of leakage surface as compared with the volume enclosed by the tent.

The effect of the size on the dose is shown by following the lines of figures lengthwise along the rule. The greater the leakage the less the effect of the size of the dose, since a decrease in size is affected by the increase in amount of leakage due to the larger relative leakage surface in the case of small trees.

By the use of this rule one may read the dose for black scale corresponding with any size and leakage. By increasing it in the proportion of $4 : 5\frac{3}{4}$ one obtains the dose for red scale and by the ratio of $4 : 7\frac{1}{2}$ that for purple.

The doses given on the rule are for the common average shaped trees in which height and width are equal and these dimensions may be read on the scale marked "diameter." To obtain the dose for trees of a different shape than this find both dimensions on this scale and the correct dose will be found at a point about two fifths way from the diameter towards the height. Or find the diameter and increase or decrease by an amount equal to two fifths of the difference between the two dimensions. Opposite this point on the scale will be found the dosage.

If one has the dimensions of a tree in circumference and distance around, the rule is not as convenient as the tables

that follow, but it is still possible to read the dose by noting the diameter on one edge of the rule which corresponds with the given circumference on the other, increasing this one fifteenth and then decreasing by an amount equal to one fifth the number of feet in the difference between the two measurements, circumference and distance over.

This rule contains the complete system of dosage based on leakage, and besides, may be used as a measure for trees according to the method given on the concluding pages of this bulletin.

THE MINIMUM DOSE.

This rule shows a fact not hitherto noted, that there is a point for each degree of leakage where the tree requires a minimum dose. With no leakage the minimum point is approximately at zero, and as the leakage increases so does the minimum dose till, as shown on the rule, 8 ounces is the least amount that will do effective work with .40 per cent leakage, which is the dose for a seven and a half foot tree. Smaller trees would require more cyanide, so much, indeed, that the danger to foliage would probably render the method impractical. The reason for increase of dose for smaller trees is the fact that the leakage surface is so large relatively to the volume of gas contained within the tent in such cases, that the percentage of gas present drops very rapidly, and must be made very strong in order that enough remain to the end of the killing period to insure the death of the insects treated. It is probably not wise to attempt to use a tent for a tree much smaller than indicated on the rule. The theoretical minima are as follows:

Leakage.	Minimum size of tree.	Dose.		
		Black Scale.	Red Scale.	Purple.
.10 per cent	2 feet.	⅛ ounce.	¼ ounce.	¼ ounce.
.15 per cent	3 feet.	½ ounce.	⅔ ounce.	1 ounce.
.20 per cent	4 feet.	1 ounce.	1½ ounces.	2 ounces.
.25 per cent	5 feet.	2 ounces.	3 ounces.	4 ounces.
.30 per cent	5½ feet.	3½ ounces.	5 ounces.	7 ounces.
.35 per cent	6½ feet.	5½ ounces.	8 ounces.	11 ounces.
.40 per cent	7½ feet.	8 ounces.	12 ounces.	15 ounces.

LEAKAGE BASIS AND ACTUAL PRACTICE.

The dosage system calculated on the leakage basis must be shown to accord with the dosages given by practical fumigators in order to be accepted with any degree of confidence, since on the whole the results of their work has been very satisfactory. For this purpose the dosage scheme for the twenty-six fumigators, as presented in Bulletin 152,

have been compared with the tables given below with the following results:

.40 per cent	none
.35 per cent	3
.30 per cent	5
.25 per cent	7
.20 per cent	8
.15 per cent	3
.10 per cent	none

In the above table each fumigator is placed in the class corresponding most closely with the record we have of his actual work.

Classifying, again, the same 26 fumigators according to the size of dose, which is quite a different thing from the rate of increase of size shown in the table above, we have

Above	5
Purple scale dose	1
Red scale dose	10
Black scale dose	5
Below	5

In both these particulars the leakage basis is thus seen to be in remarkable agreement with the practice of fumigators, simply supplying the means of determining when the system of one fumigator is to be followed and when that of another.

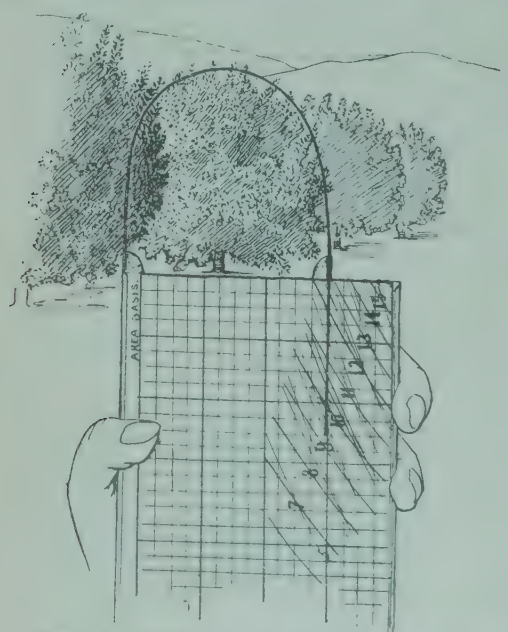


FIG. 2.—Method of scheduling with a chart.

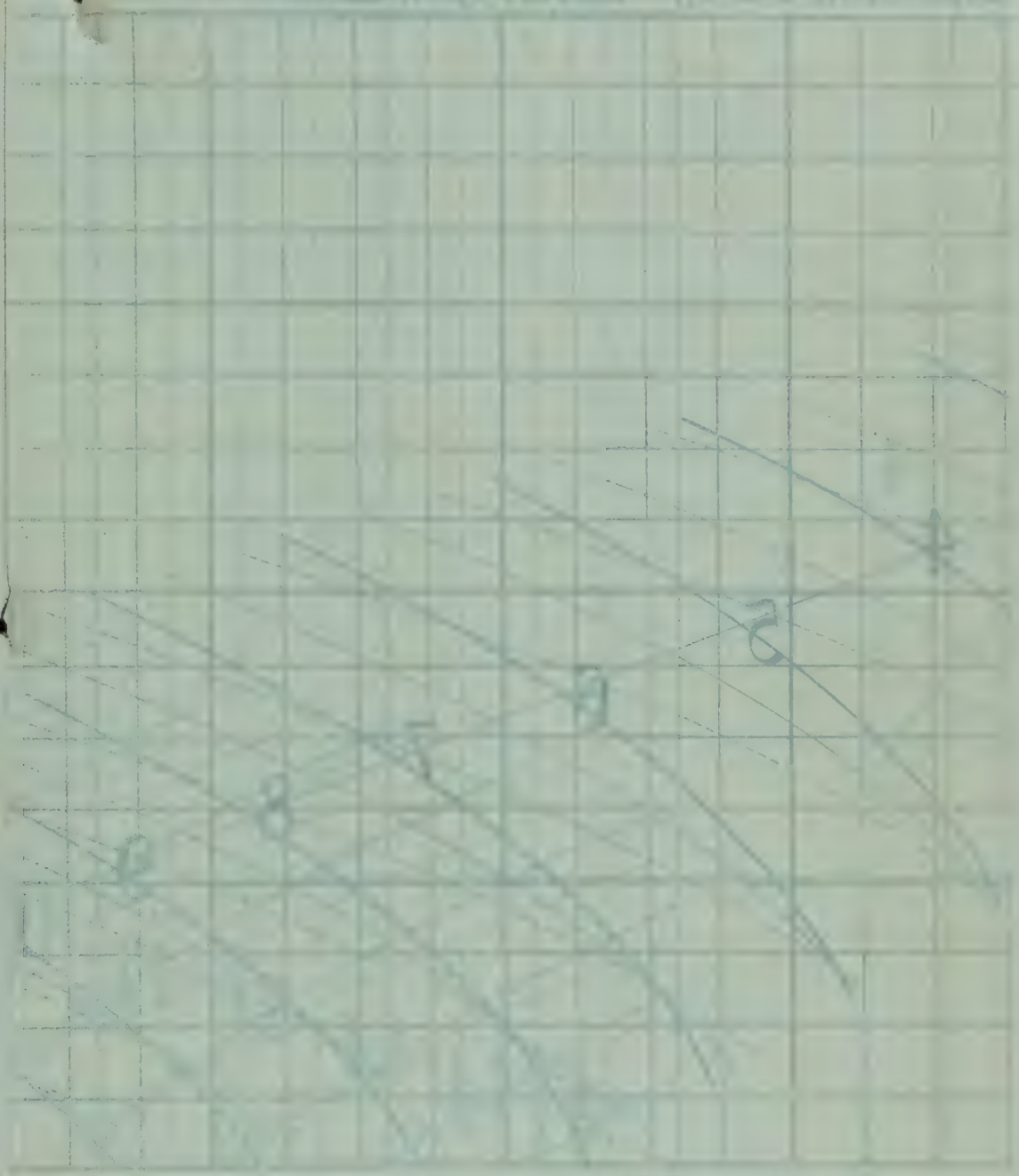
SCHEDULING CHARTS.

The study upon which this bulletin is based was undertaken largely in fulfilment of a promise made in Circular 50, where it was pointed out that while differences of leakage required the use of different bases of calculation it was impossible to specify what chart to use in any particular case. We are now able to give this very necessary information, and we, therefore, reproduce the two charts which give approximately correct dosage for the average tent and for those better than the average.

The directions accompanying the charts are revised to include these determinations, as follows:

DIRECTIONS FOR USING THE SCHEDULING CHARTS.

To use these charts one should first determine the dose for the average sized tree in the orchard to be scheduled by means of the fumigator's rule, after determining the leakage with a leakage meter.



The charts provide for leakages from 0 to .25 per cent, as follows:

Leakage.	
0	Heavy lines on volume chart.
.05%	Light lines on volume chart.
.10%	Dotted lines on volume chart.
.15%	Dotted lines on area chart.
.20%	Light lines on area chart.
.25%	Heavy lines on area chart.

For tents with greater leakage or for trees either very large or very small, use the rule instead of the charts for determining dosage.

The method of using the chart is as follows:

First—Place this chart in a holder provided with a loop of flat wire. This should project from the upper right-hand corner of the chart and extend exactly 14¾ inches.

Second—In using the chart one should always stand at a uniform distance from the tree to be measured. In most cases the most convenient point is midway between four trees (or between three trees in case the orchard is planted in oblique rows); by looking down between the rows of trees one can locate oneself quite accurately. Do not attempt to measure the nearest trees, but those just beyond. This will make the distance between thirty and forty feet, according to the way the trees are planted.

Third—The distance between the chart and the eye must also be maintained constant. Before beginning to schedule an orchard, fasten a light flexible wire around the hatband, allowing the end to project forward 8 or 10 inches, then standing opposite an average tree at the distance which you find best to measure the tree, move the slide and slip the flat wire loop till the end of the wire touches the dose line at the dose determined for the size and leakage by means of the rule. Then move the chart to or from the face till the distance across the loop corresponds with the size of the tree. Now bend the end of the wire around the hatband into a hook into which the flat wire loop will lie, holding it at the desired distance.

Fourth—Having thus adjusted the apparatus, one can proceed to measure the trees by moving the slide and slipping the wire loop until the outline of the tree exactly corresponds with the loop (the fringe of slender twigs are disregarded in day scheduling, since these will always be bent down by the tent). See that the wire lies straight across the chart, and where the end of the wire comes one may read off at once the proper dose; and should write the amount in the appropriate square. One may readily schedule four rows of trees at a time by this method for daytime work.

Fifth—When scheduling very large trees adjust the apparatus for half the dose desired and double all readings. By having hooks at each end of the wire around the hatband one hook may be set for ordinary sized trees and the other for large trees when extremes occur in the same orchard.

Sixth—Where one desires extreme accuracy in measuring, attach the transparent diagram described in the same bulletin and use a specially graduated tape, instead of the wire loop and graduations on the chart, for determining the dose. With the aid of a boy to handle one end of the tape, two rows may be scheduled about as rapidly as four rows by the former method.

Seventh—This chart may be also used for calculating the dose when direct measurements are made if one first graduates an oblique line to correspond with dimensions. Hold a card square with the sides of the diagram and in such a position that the two dimensions are indicated by the adjacent edges of the card and the corner between will indicate the dose. This will give determinations accurate to a small fraction of an ounce.

NOTE (*a*).—Some fumigators increase or decrease the dose a half ounce or more for badly infested trees, for especially dense trees, or for irregularly shaped trees. Where this is done it may be indicated on the chart by placing a dot in a corner of the appropriate square. If the dose is increased, put the dot in an upper corner; if reduced, below; and if on account of the character of the tree place the dot to the left; if because of the abundance of the scale place it in one of the right-hand corners.

DIRECT MEASUREMENTS.

Many may prefer to use direct measurements for determining the size. The most accurate method of measuring is to determine the distance around the tent or circumference, and the distance over the top. This plan was first suggested in 1899 in Bulletin 122 of this Station, and a dosage table based on volume was presented for use with such measurements. The data secured for Bulletin 152 was obtained by the use of such measurements. This method of measuring is now largely known as the Morrill or Woglum system, since these two investigators have particularly urged its adoption. The most convenient plan is to mark the tents so as to readily determine the distance over the top and use a tape line around the side for the circumference.

Such measurements give the dimensions very accurately, but must be used with properly calculated tables or the dose may be far from correct. The original table published in Bulletin 122 is accurate only for tents without leakage. No such tents are in use, but if such tents were provided the dose would be much stronger than necessary. The marking suggested in Bulletin 152 and the tables given by Morrill, Woglum, and Quayle are all based on area and are approximately right for a .25 per cent leakage, except at the two extremes, where they are all defective, particularly at the lower end and where the dose is only half large enough as compared with the center of the table. For any other degree of leakage they are incorrect throughout, though the dose recommended is high enough to be effective in most cases, notwithstanding the inaccuracy of the tables.

EXPLANATION OF THE NEW TABLES.

The tables given below are arranged in a new form which will be found very convenient in practice. In each table at the top is given the *dosage,* below the corresponding *dimensions.*

The *dosage* is given for all the ingredients instead of only for the cyanide as has been the practice in all tables heretofore offered. This will avoid the error that sometimes results from the mental calculation heretofore required to determine the amount of water (or acid in the case of sodium cyanide) to use. The amounts given are simply 3, $2\frac{1}{2}$, 2, and $1\frac{1}{2}$ times the cyanide dose. The formula recommended for sodium cyanide is $1–\frac{2}{3}–1\frac{1}{3}$, that is, 1 ounce of the acid, $\frac{2}{3}$ of an ounce of the cyanide to $1\frac{1}{3}$ ounces of water. The formula longest used for potassium cyanide is 1–1–2. If accurately measured this is sufficient water to keep the all-acid sulfate formed in solution. When the water is slightly less than this amount or the acid slightly more there is danger of the crystallization of the salt and the generator is said to "freeze." To avoid this many fumigators use 1–1–3, though with an appreciable loss of gas. The use of $1–1–2\frac{1}{2}$ gives ample water to offset inaccurate meas-

urements and by the use of these tables is as convenient as the former, though it would not be so practical if it had to be calculated mentally.

The dimensions given at the beginning of each line are the circumference, and when the distance over is the same as in high trees the dose will be read in the column above this figure. The remaining figures on each line represent the distance over the tent. To obtain the dosage of a tree, therefore, first find the circumference at the left end of a line and follow along that line till the distance over is found, and then follow up the column and read the dose.

If one decides to use the formula 1–1–2½, a line of red ink should be run through the lines beginning x3, x2, x1⅓, and x⅔, and if he does not wish to dose to the half ounce, red ink may be run through the alternate columns. The use of these red ink lines will avoid the danger of using the wrong figures.

If the dimension is smaller than any given in the table, a tighter tent should be used since it has passed below the point of minimum dose described above and effective treatment is not to be expected.

BLACK SCALE TABLE—.10 PER CENT LEAKAGE.

Water, ounces.

x3	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6	4½	3	1½				
x2½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5	3¾	2½	1¼			
x2	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
x1⅓	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔	2	1⅓	⅔			

Sodium Cyanide, ounces.

x⅔	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓	1	⅔	⅓			

Acid and Potassium Cyanide, ounces.

	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2	1½	1	½			

Dimensions—Distance around and over tent, feet.

	62	60	58	56	54	52	50	49	47	46	45	44	42	41	39	37	36	34	32	31	27								
		60	59	57	55	53	51	49	48	47	46	44	43	41	40	38	36	34	32	30	28	25							
			58	57	55	53	51	49	48	47	46	45	43	42	40	38	36	35	32	30	28	25							
				56	55	53	51	50	49	48	46	45	43	42	40	39	37	35	33	30	28	26	23						
						54	52	50	49	48	47	45	44	42	41	39	37	35	33	31	29	26	23						
							52	51	50	48	47	46	44	43	41	40	38	36	34	31	29	26	23	20					
									50	49	48	46	45	43	42	40	38	36	34	32	30	27	24	20					
											48	46	45	44	42	40	38	36	34	32	30	27	24	21	17				
												46	45	44	43	41	39	37	35	33	30	28	25	21	17				
														44	43	41	39	37	35	33	31	28	25	21	17				
																42	40	38	36	33	31	28	25	22	18				
																	40	38	36	34	32	29	26	22	18				
																		38	36	34	32	29	26	23	19				
																				35	32	30	27	23	19	13			
																				34	33	30	27	24	20	14			
																					32	30	28	24	20	14			
																						30	28	24	20	15			
																							28	25	21	15			
																							26	25	21	15			
																								24	22	16			
																									22	16			
																									20	17			
																									18	17			
																										16			
																										14			
																										12			
																										10			

BLACK SCALE TABLE—15 PER CENT LEAKAGE.

Water, ounces.

x3	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6	4½	3	1½	
x2½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5	3¾	2½	1¼	
x2	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
x1⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔	2	1⅓	⅔	

Sodium Cyanide, ounces.

x⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓	1	⅔	⅓	

Acid and Potassium Cyanide, ounces.

	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2	1½	1	½	

Dimensions—Distance around and over tent, feet.

	62	60	58	56	54	53	51	49	46	45	44	43	42	40	39	37	36	34	32	30	28	26							
		60	59	57	55	53	51	49	47	46	45	43	42	40	39	38	36	34	32	30	29	26							
			58	57	55	54	52	49	47	46	45	44	42	41	40	38	36	35	33	31	29	27	24						
					56	54	52	50	47	46	45	44	43	41	40	39	37	35	33	31	30	27	25						
						54	52	50	48	47	46	44	43	42	40	39	37	35	33	32	30	27	25	22					
							52	50	48	47	46	45	44	42	41	39	38	36	34	32	30	28	25	23					
								50	49	47	46	45	44	43	41	40	38	36	34	33	31	28	26	23	20				
										48	47	46	44	43	41	40	38	37	35	33	31	29	26	23	20				
												46	45	43	42	41	39	37	35	34	32	29	27	24	21				
														44	42	41	39	37	36	34	32	29	27	24	21	18			
															42	41	40	38	36	34	32	30	27	25	22	18			
																	40	38	36	35	33	30	28	25	22	18			
																		38	37	35	33	31	28	25	22	19	15		
																				36	34	31	29	26	23	19	15		
																					34	32	29	26	23	20	16		
																						32	30	27	24	20	16		
																							30	27	24	21	16		
																								28	24	21	17	10	
																								26	23	21	17	10	
																									24	22	18	10	
																										22	18	11	
																										20	18	11	
																											18	12	
																											16	12	
																											14	12	
																												12	
																												10	

BLACK SCALE TABLE—.20 PER CENT LEAKAGE.

Water, ounces.

x3	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6	4½	3
x2½	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5	3¾	2½
x2	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
x1⅓	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔	2	1⅓

Sodium Cyanide, ounces.

x⅔	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓	1	⅔

Acid and Potassium Cyanide, ounces.

	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2	1½	1

Dimensions—Distance around and over tent, feet.

	62	61	59	58	56	55	53	52	51	49	48	45	44	42	41	40	39	38	37	35	33	31	30	28	26				
			60	59	57	55	54	52	51	50	48	46	44	43	42	41	40	38	37	35	34	32	30	29	27	25			
				58	57	56	54	53	51	50	48	46	44	43	42	41	40	39	37	36	34	33	31	29	27	25			
						56	55	53	52	51	49	47	45	43	42	41	40	39	38	36	35	33	31	29	27	26	23		
								54	52	51	49	47	45	44	43	42	41	40	38	37	35	33	32	30	28	26	24		
									52	51	50	47	46	44	43	42	41	40	39	37	35	34	32	30	28	26	24	21	
											50	48	46	45	44	43	41	40	39	37	36	34	32	30	28	27	24	22	19
												48	46	45	44	43	42	41	39	38	36	35	33	31	29	27	25	22	19
														46	45	43	42	41	40	38	36	35	33	31	29	27	25	23	20
																44	43	41	40	39	37	35	34	32	30	28	25	23	20	17
																		42	41	39	37	36	34	32	30	28	26	23	20	17
																			40	39	38	36	34	33	31	29	26	24	21	18
																					38	37	35	33	31	29	27	24	21	18
																						36	35	33	31	30	28	25	22	18
																								33	32	30	28	25	22	19
																									32	30	28	25	22	19
																										30	28	26	23	20
																											28	26	23	20
																												26	24	21
																													24	21
																													22	21
																														20
																														18
																														16
																														14
																														12
																														10

BLACK SCALE TABLE—.2% PER CENT LEAKAGE.

Water, ounces.

x3	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	
x2½	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	
x2	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	
x1⅓	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	

Sodium Cyanide, ounces.

x⅔	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	2⅓	2	1⅔	1⅓	2	

Acid and Potassium Cyanide, ounces.

	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	

Dimensions—Distance around and over tent, feet.

	62	60	57	56	55	53	51	50	48	46	44	41	39	38	37	35	34	33	31	30	28	26						
		60	58	56	55	53	51	50	48	46	44	42	40	38	37	36	35	33	32	30	28	27	25					
			58	57	55	54	52	50	48	46	44	42	40	39	37	36	35	34	32	30	29	27	25	23				
					56	54	52	51	49	47	45	43	41	39	38	37	36	34	33	31	29	27	25	23				
						54	53	51	49	47	45	43	41	39	38	37	36	34	33	31	30	28	26	24	22			
								52	50	48	45	43	42	40	39	37	36	35	33	32	30	28	26	24	22			
									50	48	46	44	42	40	39	38	37	35	34	32	30	29	26	24	22	20		
										48	46	44	42	40	39	38	37	36	34	33	31	29	27	25	23	21	18	
											46	45	43	41	40	38	37	36	34	33	31	29	27	25	23	21	18	
												44	43	41	40	39	38	36	35	33	32	30	28	26	24	21	18	
														42	41	39	38	37	35	34	32	30	28	26	24	22	19	
																40	39	37	36	34	32	31	28	26	24	22	19	
																	38	37	36	34	33	31	29	27	25	22	19	
																			36	35	33	31	29	27	25	23	20	
																					34	32	30	28	26	23	20	
																						32	30	28	26	24	21	
																							30	29	26	24	21	
																								28	27	24	21	
																									26	25	22	
																										24	22	
																											22	
																											20	
																											18	
																											16	
																											14	

BLACK SCALE TABLE—.30 PER CENT LEAKAGE.

Water, ounces.

x3	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12
x2½	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10
x2	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8
x1⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓

Sodium Cyanide, ounces.

x⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔

Acid and Potassium Cyanide, ounces.

	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4

Dimensions—Distance around and over tent, feet.

	62	59	57	54	52	51	49	47	46	44	42	40	37	35	33	32	31	29	28	27					
		60	57	54	53	51	49	48	46	44	42	40	38	35	34	32	31	30	29	27	25				
		58	57	55	53	51	50	48	46	44	42	41	38	36	34	33	31	30	29	27	26	24			
			56	55	53	52	50	48	47	45	43	41	39	36	34	33	32	31	29	28	26	24			
					54	52	51	49	47	45	43	41	39	36	35	33	32	31	30	28	27	25	23		
						52	51	49	47	46	44	42	39	37	35	34	33	31	30	29	27	25	23	21	
								50	48	46	44	42	40	37	36	34	33	32	30	29	27	26	24	21	
									48	46	44	42	40	38	36	35	33	32	31	29	28	26	24	22	19
										46	45	43	40	38	36	35	34	33	31	30	28	26	24	22	20
											44	43	41	39	37	35	34	33	32	30	28	27	25	22	20	17
												42	41	39	37	36	35	33	32	30	29	27	25	23	20	17
													40	39	37	36	35	34	32	31	29	27	25	23	20	17
															38	37	35	34	33	31	30	28	26	23	21	18
																	36	35	33	32	30	28	26	24	21	18
																			34	32	30	29	27	24	22	19
																				32	31	29	27	25	22	19
																						30	27	25	22	19
																							28	25	23	20
																								26	23	20
																									24	21
																									22	21
																										20
																										18
																										16

BLACK SCALE TABLE—3[illegible] PER CENT LEAKAGE.

Water, ounces.

x3	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18
x2½	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15
x2	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12
x1⅓	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8

Sodium Cyanide, ounces.

x⅔	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5½	5	4⅔	4⅓	4

Acid and Potassium Cyanide, ounces.

30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6

Dimensions—Distance around and over tent, feet.

62	60	58	53	53	50	48	47	45	43	42	40	38	36	33	31	29	27	26					
	60	58	56	53	50	49	47	46	44	42	40	38	36	34	31	29	28	26	25				
		58	56	54	51	49	48	46	44	42	40	39	36	34	32	30	28	27	25	24			
			56	54	51	49	48	46	45	43	41	39	37	35	32	30	29	27	26	24			
				54	52	50	48	47	45	43	41	39	37	35	32	30	29	28	26	24	22		
					52	50	49	47	45	44	42	40	38	36	33	31	30	28	27	25	23	21	
						50	49	47	46	44	42	40	38	36	33	31	30	28	27	25	23	21	
								48	46	44	42	40	38	36	34	32	30	29	27	25	24	21	19
									46	45	43	41	39	37	34	32	31	29	28	26	24	22	19
										44	43	41	39	37	34	32	31	30	28	26	24	22	20
												42	40	37	35	33	31	30	29	27	25	23	20
													40	38	35	33	32	30	29	27	25	23	21
														38	36	34	32	31	29	27	25	23	21
															36	34	33	31	30	28	26	24	21
																34	33	32	30	28	26	24	22
																		32	30	29	27	25	22
																			30	29	27	25	22
																					28	25	23
																						26	24
																							24
																							22
																							20
																							18

BLACK SCALE TABLE—.40 PER CENT LEAKAGE.

Water, ounces.

x3	102	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27
x2½	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½
x2	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18
x1⅓	45⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12

Sodium Cyanide, ounces.

x⅔	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6

Acid and Potassium Cyanide, ounces.

	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9

Dimensions—Distance around and over tent, feet.

	62	61	58	56	54	51	48	46	44	42	40	39	37	35	33	30	28		
		60	59	57	54	51	49	46	44	43	41	39	37	35	33	31	28	25	
			58	57	55	52	49	47	45	43	42	40	38	36	34	31	29	26	
				56	55	52	50	47	45	44	42	40	38	36	34	32	29	26	23
					54	53	50	48	46	44	43	41	39	37	35	32	30	27	24
						52	50	48	46	45	43	41	39	37	35	33	30	27	24
							50	48	46	45	43	41	39	38	36	33	30	27	24
								48	47	45	44	42	40	38	36	33	31	28	25
										46	44	42	40	38	36	34	31	28	25
											44	42	40	38	37	34	31	28	25
												42	40	39	37	35	32	29	26
													40	39	37	35	32	29	26
															38	35	33	30	27
																36	33	30	27
																34	33	30	27
																	32	31	28
																		30	28
																			28

RED SCALE TABLE—.10 PER CENT LEAKAGE.

Water, ounces.

x3	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6	4½	3	1½
x2½	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5	3¾	2½	1¼
x2	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
x1⅓	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔	2	1⅓	⅔

Sodium Cyanide, ounces.

x⅔	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓	1	⅔	⅓

Acid and Potassium Cyanide, ounces.

	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2	1½	1	½

Dimensions—Distance around and over tent, feet.

62	59	57	56	55	53	52	50	49	47	46	44	42	40	39	38	36	35	34	33	32	30	29	27							
	60	58	56	55	53	52	51	49	48	46	44	42	41	39	38	37	35	34	33	32	31	29	27	25						
		59	57	56	54	53	51	50	48	46	45	43	41	40	39	37	36	35	34	33	31	30	28	26						
				56	54	53	52	50	48	47	45	43	41	40	39	37	36	35	34	33	31	30	28	26	24					
					54	53	52	50	49	47	45	43	42	40	39	38	36	35	34	33	32	30	29	26	24	22				
							52	51	49	48	46	44	42	41	40	38	37	36	35	34	32	31	29	27	25	23				
									50	48	46	44	42	41	40	39	37	36	35	34	33	31	29	27	25	23	21			
										48	46	44	43	42	41	39	38	36	35	34	33	31	30	27	25	23	21	19		
											46	45	43	42	41	39	38	37	36	35	33	32	30	28	26	24	22	19		
													44	42	41	40	38	37	36	35	34	32	30	28	26	24	22	20	17	
															42	40	39	38	37	36	34	33	31	29	27	25	22	20	17	
																40	39	38	37	36	35	33	31	29	27	25	23	20	17	
																		38	37	36	35	33	32	30	27	25	23	21	18	14
																				36	35	34	32	30	28	26	24	21	18	14
																						34	33	30	28	26	24	22	19	15
																							32	31	29	27	24	22	19	15	11
																								30	29	27	25	22	19	16	11
																									28	27	25	23	20	16	11
																											26	23	20	16	12
																												24	21	17	12
																												22	21	17	12
																													20	18	13
																														18	13
																														16	14
																															14
																															12
																															10

RED SCALE TABLE—.15 PER CENT LEAKAGE.

Water, ounces.

x3	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6	4½	3
x2½	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5	3¾	2½
x2	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
x1⅓	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔	2	1⅓

Sodium Cyanide, ounces.

x⅔	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓	1	⅔

Acid and Potassium Cyanide, ounces.

28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2	1½	1

Dimensions—Distance around and over tent, feet.

62	61	59	56	54	53	52	50	48	47	45	43	42	41	38	37	36	34	33	32	30	29	28	27									
	60	59	57	54	53	52	50	49	47	45	44	43	41	39	37	36	35	33	32	31	30	29	27	25								
		58	57	55	53	52	50	49	48	46	44	43	41	39	38	36	35	34	32	31	30	29	28	26	24							
			56	55	54	53	51	50	48	46	45	43	42	40	38	37	36	34	33	31	30	29	28	26	24	23							
					54	53	51	50	48	47	45	44	42	40	38	37	36	35	33	32	31	30	28	27	25	23							
							52	50	49	47	45	44	43	40	39	38	36	35	34	32	31	30	29	27	25	24	22						
								50	49	47	46	45	43	41	39	38	37	35	34	33	32	31	29	27	26	24	22	20					
										48	46	45	43	41	40	38	37	36	34	33	32	31	30	28	26	24	22	21					
											46	45	44	41	40	39	38	36	35	33	32	31	30	28	26	25	23	21	18				
													44	42	40	39	38	36	35	34	33	32	30	29	27	25	23	22	19				
														42	41	40	38	37	35	34	33	32	31	29	27	25	23	22	19	16			
																40	39	37	36	35	34	33	31	29	28	26	24	22	19	16			
																		38	36	35	34	33	31	30	28	26	24	23	20	17	14		
																				36	35	34	32	30	29	27	25	23	20	17	14		
																						34	32	31	29	27	25	24	21	18	15	11	
																								32	30	28	26	24	21	18	15	11	
																									30	28	26	24	21	19	16	12	
																										28	26	25	22	19	16	12	
																											26	25	22	19	16	12	
																												24	23	20	17	13	
																													22	20	17	13	
																														20	18	14	
																															18	14	
																															16	14	
																																14	
																																12	
																																10	

RED SCALE TABLE—.20 PER CENT LEAKAGE.

Water, ounces.

x3----	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6
x2½---	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5
x2----	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4
x1⅓---	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔

Sodium Cyanide, ounces.

x⅔----	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓

Acid and Potassium Cyanide, ounces.

	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2

Dimensions—Distance around and over tent, feet.

62	61	58	55	53	50	48	47	45	44	43	41	40	38	37	35	34	33	31	30	29	27	26								
	60	59	56	53	50	49	47	46	45	43	42	40	39	37	35	34	33	32	31	29	28	26	25							
		58	57	54	51	49	48	46	45	43	42	41	39	38	36	35	34	32	31	30	28	27	25	24						
			56	54	51	50	48	47	45	44	42	41	40	38	36	35	34	33	31	30	29	27	26	24						
				54	51	50	49	47	46	44	43	41	40	38	37	36	34	33	32	31	29	27	26	24	22					
					52	50	49	47	46	45	43	42	40	39	37	36	35	34	32	31	30	28	26	25	23	21				
							50	48	47	45	44	42	41	39	37	36	35	34	33	31	30	28	27	25	23	22				
								48	47	45	44	43	41	40	38	37	36	34	33	32	30	29	27	26	24	22	20			
										46	44	43	41	40	38	37	36	35	34	32	31	29	28	26	24	22	20	18		
											44	43	42	40	39	38	36	35	34	33	31	29	28	26	24	23	20	18	16		
													42	41	39	38	37	36	35	33	32	30	28	27	25	23	21	19	17		
															40	38	37	36	35	33	32	30	29	27	25	24	21	19	17	15	
																	38	36	35	34	32	31	29	28	26	24	22	20	18	15	
																			36	34	33	31	30	28	26	24	22	20	18	15	13
																				34	33	32	30	28	26	25	23	20	18	16	13
																						32	30	29	27	25	23	21	19	16	14
																								30	27	26	23	21	19	17	14
																									28	26	24	22	20	17	15
																										26	24	22	20	17	15
																											24	22	20	18	16
																												22	21	18	16
																													20	19	16
																														18	17
																															16
																															14
																															12
																															10

RED SCALE TABLE—.25 PER CENT LEAKAGE.

Water, ounces.

x3	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½
x2½	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾
x2	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7
x1⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔

Sodium Cyanide, ounces.

x⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓

Acid and Potassium Cyanide, ounces.

	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½

Dimensions—Distance around and over tent, feet.

	62	60	57	54	51	48	46	44	43	41	40	38	37	35	34	32	30	29	28	27	26									
		60	57	55	52	49	46	45	43	42	40	39	37	36	34	33	31	30	28	27	26	25								
			58	55	52	49	46	45	43	42	40	39	38	36	35	33	31	30	29	28	26	25	24							
				56	53	50	47	45	44	43	41	40	38	37	35	33	32	30	29	28	27	26	24	23						
				54	53	50	47	46	44	43	41	40	39	37	36	34	32	31	30	29	27	26	24	23						
					52	50	48	46	45	43	42	40	39	37	36	34	33	31	30	29	28	26	25	23	21					
							48	47	45	44	42	41	40	38	37	35	33	32	31	30	28	27	25	24	22	20				
									46	45	43	41	40	38	37	35	34	32	31	30	29	27	25	24	22	21	19			
										44	43	42	40	39	38	36	34	33	32	30	29	28	26	24	23	21	19			
												42	40	39	38	36	35	33	32	31	30	28	26	25	23	21	19	17		
														40	38	37	35	34	32	31	30	29	27	25	23	22	20	18		
															38	37	35	34	33	32	30	29	27	26	24	22	20	18	16	
																	36	35	33	32	31	30	28	26	24	23	21	19	16	
																			34	33	31	30	28	27	25	23	21	19	17	13
																					32	30	28	27	25	23	22	20	17	14
																						30	28	27	26	24	22	20	18	14
																								26	25	24	22	20	18	15
																										24	22	21	19	15
																											22	21	19	15
																												20	19	16
																													18	16
																														16
																														14
																														12
																														10

RED SCALE TABLE—.30 PER CENT LEAKAGE.

Water, ounces.

x3	108	102	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½
x2½	90	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾
x2	72	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11
x1⅓	48	45⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓

Sodium Cyanide, ounces.

x⅔	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔

Acid and Potassium Cyanide, ounces.

	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½

Dimensions—Distance around and over tent, feet.

	62	61	58	56	54	51	47	45	42	41	39	37	36	35	33	31	30	28	26								
		60	59	56	54	51	48	45	42	41	40	38	36	35	33	32	30	28	26								
			58	57	54	52	48	45	43	41	40	38	37	35	34	32	30	28	26	25							
				56	55	52	49	46	43	42	40	39	37	36	34	32	31	29	27	25	23						
					54	52	49	46	44	42	41	39	38	36	35	33	31	29	27	26	24	23					
						52	49	47	44	43	41	40	38	37	35	33	32	30	28	26	24	23	21				
							50	47	45	43	42	40	38	37	35	34	32	30	28	26	25	23	21	20			
								48	45	44	42	40	39	37	36	34	32	30	28	27	25	24	22	20	19		
								46	45	44	42	41	39	38	36	34	33	31	29	27	25	24	22	21	19	18	
										44	43	41	40	38	37	35	33	31	29	28	26	24	23	21	20	18	
												42	40	39	37	35	33	32	30	28	26	25	23	22	20	18	17
													40	39	37	36	34	32	30	28	27	25	23	22	20	19	17	15
															38	36	34	32	30	29	27	26	24	22	21	19	17	15
																36	35	33	31	29	27	26	24	23	21	20	18	16
																	34	33	31	30	28	26	25	23	22	20	18	16
																			32	30	28	27	25	24	22	20	19	16
																				30	29	27	25	24	22	21	19	17
																						28	26	24	23	21	20	17
																							26	25	23	22	20	17
																									24	22	20	18
																										22	21	18
																											20	19
																												18
																												16

RED SCALE TABLE—.35 PER CENT LEAKAGE.

Water, ounces.

x3	114	108	102	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½
x2½	95	90	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼
x2	76	72	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17
x1⅓	50⅔	48	45⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓

Sodium Cyanide, ounces.

x⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔

Acid and Potassium Cyanide, ounces.

38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½

Dimensions—Distance around and over tent, feet.

62	59	57	55	52	50	47	44	41	39	37	35	34	32	30	29	27						
	60	58	55	53	51	48	44	42	39	37	35	34	32	30	29	27	25					
		58	55	53	51	48	45	42	40	38	36	34	33	31	30	28	26					
			56	54	52	49	45	43	40	38	36	35	33	31	30	28	26	24				
				54	52	49	46	43	40	39	37	35	33	32	30	29	26	24	22			
					52	49	46	43	41	39	37	36	34	32	31	29	27	25	22			
						50	47	44	41	39	37	36	34	33	31	29	27	25	23	20		
						48	47	44	41	40	38	36	35	33	32	30	27	25	23	21	19	
							46	45	42	40	38	37	35	33	32	30	28	26	23	21	19	
								44	42	40	39	37	35	34	32	30	28	26	24	22	19	17
									42	41	39	38	36	34	33	31	29	27	24	22	20	18
										40	39	38	36	35	33	31	29	27	24	22	20	18
												38	37	35	34	32	30	28	25	23	21	19
														36	34	32	30	28	25	23	21	19
															34	33	30	28	26	24	22	20
																32	31	29	26	24	22	20
																	30	29	27	25	22	20
																		28	27	25	23	21
																			26	25	23	21
																					24	22
																						22
																						20
																						18

RED SCALE TABLE—.40 PER CENT LEAKAGE.

Water, ounces.

x3	132	120	114	108	102	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36
x2½	110	100	95	90	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30
x2	88	80	76	72	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24
x1⅓	58⅔	53⅓	50⅔	48	45⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16

Sodium Cyanide, ounces.

x⅔	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8

Acid and Potassium Cyanide, ounces.

	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12

Dimensions—Distance around and over tent, feet.

	62	61	59	56	53	50	48	46	44	41	38	35	32	30	28	26				
		60	59	56	54	51	49	47	44	41	38	35	33	30	29	27				
			58	56	54	51	49	47	44	42	38	35	33	31	29	27	25			
				56	54	52	50	47	45	42	39	36	33	31	30	27	25	23		
					54	52	50	48	45	43	39	36	34	31	30	28	25	23		
						52	50	48	45	43	40	37	34	32	30	28	26	24		
							50	48	46	43	40	37	35	33	31	29	26	24	20	
								48	46	44	40	37	35	33	31	29	26	25	21	
									46	44	41	38	35	33	31	29	27	25	21	
										44	41	38	36	34	32	30	27	25	21	17
											42	39	36	34	32	30	28	26	22	18
											40	39	37	35	33	31	28	26	22	18
												38	37	35	33	31	29	26	23	19
													36	35	34	31	29	27	23	19
															34	32	30	27	23	19
																32	30	28	24	20
																	30	28	24	20
																		28	25	21
																		26	25	21
																			24	22
																				22
																				20

PURPLE SCALE TABLE—.10 PER CENT LEAKAGE.

Water, ounces.

x3	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6	4½	3	1½
x2½	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5	3¾	2½	1¼
x2	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
x1⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔	2	1⅓	⅔

Sodium Cyanide, ounces.

x⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓	1	⅔	⅓

Acid and Potassium Cyanide, ounces.

	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2	1½	1	½

Dimensions—Distance around and over tent, feet.

	58	56	54	51	50	49	47	46	45	44	42	41	39	37	36	34	33	32	31	30	29	27	26								
	59	57	55	52	50	49	48	47	46	44	43	41	39	38	36	35	34	33	32	30	29	28	27	25							
	58	57	55	52	51	50	48	47	46	45	43	42	40	38	36	35	34	33	32	31	30	28	27	26	24						
		56	55	53	51	50	49	47	46	45	43	42	40	38	36	35	34	33	32	31	30	29	28	26	25	23					
			54	53	51	50	49	48	47	45	44	42	40	39	37	36	35	34	33	31	30	29	28	26	25	23					
					52	51	50	48	47	46	44	43	41	39	37	36	35	34	33	32	31	30	28	27	25	24	22				
							50	49	48	46	45	43	41	39	38	37	36	35	34	32	31	30	29	27	26	24	22	20			
									48	47	45	44	42	40	38	37	36	35	34	33	32	30	29	28	26	25	23	20			
										46	45	44	42	40	39	37	36	35	34	33	32	31	30	28	27	25	23	21	19		
												44	43	41	39	38	37	36	35	33	32	31	30	28	27	25	23	21	19	17	
													42	41	40	38	37	36	35	34	33	32	30	29	27	26	24	22	19	17	
															40	39	38	37	35	34	33	32	31	29	28	26	24	22	20	18	15
																	38	37	36	35	34	33	31	30	28	27	25	22	20	18	15
																			36	35	34	33	32	30	29	27	25	23	21	19	15
																					34	33	32	31	29	27	25	23	21	19	16
																							32	31	30	28	26	24	22	19	16
																									30	28	26	24	22	20	17
																										28	27	24	22	20	17
																											26	25	23	21	18
																												24	23	21	18
																														22	18
																														20	19
																															18

PURPLE SCALE TABLE—.15 PER CENT LEAKAGE.

Water, ounces.

x3	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6	4½	3
x2½	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6	5	3¾	2½
x2	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
x1⅓	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔	2	1⅓

Sodium Cyanide, ounces.

x⅔	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓	1	⅔

Acid and Potassium Cyanide, ounces.

	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2	1½	1

Dimensions—Distance around and over tent, feet.

	56	54	52	50	48	46	45	44	43	42	40	39	37	36	33	32	31	30	29	28	26										
	57	55	53	51	49	47	46	45	43	42	41	39	38	36	34	32	31	30	29	28	27	26	25								
	57	55	53	51	49	47	46	45	44	43	41	40	38	36	34	33	32	31	30	29	27	26	25	24							
		56	54	51	49	47	46	45	44	43	42	40	38	37	35	33	32	31	30	29	27	26	25	24	23						
			54	52	50	48	47	46	45	43	42	41	39	37	35	34	33	32	31	29	28	27	26	25	23	22					
				52	50	48	47	46	45	44	43	41	39	38	36	34	33	32	31	30	28	27	26	25	24	22	21				
					50	49	48	46	45	44	43	42	40	38	36	34	33	32	31	30	29	28	27	25	24	23	21				
							48	47	46	45	43	42	40	38	36	35	34	33	32	30	29	28	27	26	24	23	22	20			
									46	45	44	42	40	39	37	35	34	33	32	31	30	28	27	26	25	24	22	20	18		
											44	42	41	39	37	36	35	34	33	31	30	29	28	26	25	24	22	20	18		
												42	41	39	37	36	35	34	33	32	30	29	28	27	25	24	23	21	18	16	
														40	38	36	35	34	33	32	31	30	29	27	26	25	23	21	19	16	
															38	37	36	35	34	32	31	30	29	28	26	25	24	22	19	17	14
																	36	35	34	33	32	30	29	28	27	26	24	22	20	17	15
																			34	33	33	31	30	29	27	26	24	22	20	18	15	12
																					32	31	30	29	28	26	25	23	20	18	16	12	
																							30	29	28	27	25	23	21	19	16	12	
																									28	27	26	24	21	19	16	13	
																											26	24	21	19	17	13	9
																												24	22	20	17	13	9
																													22	20	18	14	10
																														20	18	14	10
																															18	15	10
																															16	15	11
																																14	11
																																	12
																																	10

x3	108	102	96	90
x2½	90	85	80	75
x2	72	68	64	60
x1⅓	48	45⅓	42⅔	40
x⅔	24	22⅔	21⅓	20
	36	34	32	30
	62	61	60	58
			60	58
				58

PURPLE SCALE TABLE—.20 PER CENT LEAKAGE.

Water, ounces.

x3	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12	10½	9	7½	6
x2½	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10	8¾	7½	6¼	5
x2	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4
x1⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓	4⅔	4	3⅓	2⅔

Sodium Cyanide, ounces.

x⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔	2⅓	2	1⅔	1⅓

Acid and Potassium Cyanide, ounces.

	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2

Dimensions—Distance around and over tent, feet.

	56	54	52	51	49	47	44	42	41	40	39	38	36	35	33	32	30	28	27	26										
	56	55	53	51	50	47	45	43	42	41	40	38	37	35	34	32	30	29	28	27	25									
	57	55	53	51	50	48	45	43	42	41	40	39	37	36	34	32	30	29	28	27	26	25								
	56	55	54	52	50	48	45	44	43	42	40	39	38	36	35	33	31	29	28	27	26	25	24	23						
			54	52	51	49	46	44	43	42	41	40	38	37	35	33	31	30	29	28	26	25	24	23	22					
				52	51	49	46	45	44	42	41	40	39	37	35	34	32	30	29	28	27	26	25	23	22	21				
					50	49	46	45	44	43	41	40	39	37	36	34	32	30	29	28	27	26	25	24	23	21	20			
						48	47	45	44	43	42	41	39	38	36	34	32	31	30	29	28	26	25	24	23	22	20	19		
								46	45	44	42	41	40	38	37	35	33	31	30	29	28	27	26	25	24	22	21	19		
										44	43	41	40	38	37	35	33	32	31	30	28	27	26	25	24	23	21	20	18	
												42	41	39	37	36	34	32	31	30	29	28	27	25	24	23	22	20	18	16
														40	38	36	34	32	31	30	29	28	27	26	25	23	22	20	19	16
															38	36	34	33	32	31	30	29	27	26	25	24	22	21	19	17
																36	35	33	32	31	30	29	28	27	26	24	23	21	20	17
																		34	33	32	31	30	29	28	27	26	25	23	22	20	18
																				32	31	30	29	28	27	26	25	24	22	21	19
																						30	29	28	27	26	25	24	22	21	19
																								28	27	26	25	24	23	22	20
																										26	25	23	22	21	20
																												24	22	22	20
																													22	22	20
																														20	18
																															18
x3	120	114	108	102																											
x2½	100	95	90	85																											
x2	80	76	72	68																											
x1⅓	53⅓	50⅔	48	45⅓																											
x⅔	26⅔	25⅓	24	22⅔																											
	40	38	36	34																											
	62	60	58	57																											
		60	59	58																											
				58																											

PURPLE SCALE TABLE—.25 PER CENT LEAKAGE.

Water, ounces.

x3	114	108	102	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½	18	16½	15	13½	12
x2½	95	90	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼	15	13¾	12½	11¼	10
x2	76	72	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9	8
x1⅓	50⅔	48	45⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6	5⅓

Sodium Cyanide, ounces.

x⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓	4	3⅔	3⅓	3	2⅔

Acid and Potassium Cyanide, ounces.

	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½	6	5½	5	4½	4

Dimensions—Distance around and over tent, feet.

	56	54	53	52	50	49	47	45	43	40	39	38	36	35	34	33	31	30	28	26										
	56	55	54	52	51	49	47	45	43	41	39	38	37	35	34	33	32	30	28	26	25									
	57	55	54	53	51	50	48	46	44	41	40	38	37	36	35	34	32	31	29	27	25	24								
		56	55	53	51	50	48	46	44	41	40	39	38	36	35	34	33	31	29	27	25	24	23							
				54	52	50	49	46	44	42	40	39	38	36	35	34	33	32	30	27	26	25	24	23						
					52	51	49	47	45	42	41	40	38	37	36	35	33	32	30	28	26	25	24	23	22					
						50	49	47	45	43	41	40	39	37	36	35	34	32	30	28	26	25	24	23	22	21				
								48	46	43	42	41	39	38	37	36	34	33	31	29	27	26	25	24	23	21	20			
									46	44	42	41	40	38	37	36	35	33	31	29	27	26	25	24	23	21	20	19		
										44	42	41	40	39	38	36	35	34	32	30	28	27	26	25	24	22	21	19	18	
												42	40	39	38	37	35	34	32	30	28	27	26	25	24	22	21	20	18	17
														40	38	37	36	34	32	30	28	27	26	25	24	22	21	20	19	17	15
																38	36	35	33	31	29	28	27	26	25	23	22	20	19	17	15
																	36	35	33	31	29	28	27	26	25	23	22	21	19	18	16	13
																			34	31	30	29	28	27	25	24	23	21	20	18	16	13
																				32	30	29	28	27	26	24	23	22	20	19	17	14
																						30	29	27	26	25	24	22	21	19	17	14
																								28	27	25	24	22	21	20	17	14
																										26	24	23	21	20	18	15
																											24	23	22	20	18	15
																													22	21	18	16
																														20	19	16
																															18	16
																																16
																																14
																																12
																																10

x3	144	132	120
x2½	120	110	100
x2	96	88	80
x1⅓	64	58⅔	53⅓
x⅔	32	29⅓	26⅔
	48	44	40
	62	59	57
		60	57
			58

PURPLE SCALE TABLE—.30 PER CENT LEAKAGE.

Water, ounces.

x3	168	156	144	132	120	114	108	102	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33	30	28½	27	25½	24	22½	21	19½
x2½	140	130	120	110	100	95	90	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½	25	23¾	22½	21¼	20	18¾	17½	16¼
x2	112	104	96	88	80	76	72	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13
x1⅓	74⅔	69⅓	64	58⅔	53⅓	50⅔	48	45⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔

Sodium Cyanide, ounces.

x⅔	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓	6⅔	6⅓	6	5⅔	5⅓	5	4⅔	4⅓

Acid and Potassium Cyanide, ounces.

56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11	10	9½	9	8½	8	7½	7	6½

Dimensions—Distance around and over tent, feet.

62	61	58	56	54	52	51	49	48	46	45	43	41	39	36	34	33	32	31	30	28	27									
	60	59	56	54	53	51	50	48	46	45	43	41	39	37	35	34	33	31	30	29	27	26								
		58	57	54	53	52	50	49	47	45	43	42	39	37	35	34	33	32	30	29	28	26	24							
			56	55	53	52	50	49	47	46	44	42	40	37	36	35	33	32	31	30	28	26	25							
					54	53	51	49	48	46	44	42	40	38	36	35	34	33	31	30	28	27	25	22						
						52	51	50	48	46	45	43	41	38	36	35	34	33	32	30	29	27	25	23	21					
								50	49	47	45	43	41	39	37	36	35	33	32	31	29	28	26	23	21	20				
									48	47	45	44	41	39	37	36	35	34	33	31	30	28	26	23	21	20	19			
											46	44	42	39	38	36	35	34	33	32	30	28	26	24	22	21	20	18		
												44	42	40	38	37	36	35	33	32	30	29	27	24	22	21	20	18		
													42	40	38	37	36	35	34	32	31	29	27	25	23	22	20	18	16	
														40	39	37	36	35	34	33	31	30	28	25	23	22	21	19	17	15
																38	37	36	35	33	32	30	28	25	23	22	21	19	17	15
																		36	35	34	32	30	28	26	24	23	21	20	18	16	13
																				34	33	31	29	26	24	23	22	20	18	16	13
																						32	30	27	25	24	23	21	19	17	14
																							30	27	25	24	23	21	19	17	14
																								28	26	24	23	21	19	17	14
																									26	25	24	22	20	18	15
																											24	22	20	18	15
																												22	20	19	16
																													20	19	16
																														18	16
																															16

PURPLE SCALE TABLE—35 PER CENT LEAKAGE.

Water, ounces.

x3	192	180	168	156	144	132	120	114	108	102	96	90	84	78	72	66	60	57	54	51	48	45	42	39	36	33
x2½	160	150	140	130	120	110	100	95	90	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35	32½	30	27½
x2	128	120	112	104	96	88	80	76	72	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22
x1⅓	85⅓	80	74⅔	69⅓	64	58⅔	53⅓	50⅔	48	45⅓	42⅔	40	37⅓	34⅔	32	29½	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔

Sodium Cyanide, ounces.

x⅔	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓	8⅔	8	7⅓

Acid and Potassium Cyanide, ounces.

	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14	13	12	11

Dimensions—Distance around and over tent, feet.

	62	59	57	54	52	50	49	47	46	44	43	41	39	37	34	32	30	29	27	26							
		60	57	55	53	50	49	48	46	44	43	41	39	37	35	32	31	29	28	26	25						
		58	57	55	53	50	49	48	46	45	43	42	40	38	35	33	31	30	28	27	25	24					
			56	55	53	51	50	49	47	45	44	42	40	38	36	33	31	30	29	27	26	24					
					54	51	50	49	47	46	44	42	41	38	36	33	32	31	29	28	26	25	23				
						52	51	49	47	46	45	43	41	39	36	34	32	31	30	28	27	25	23	21			
								50	48	46	45	43	41	39	37	34	33	32	30	28	27	26	24	22	20		
									48	47	45	43	42	40	37	35	33	32	30	29	27	26	24	22	20		
											46	44	42	40	38	35	34	32	31	29	28	26	24	23	20		
												44	43	40	38	35	34	33	31	30	28	27	25	23	21		
													42	41	38	36	34	33	31	30	29	27	25	23	21	16	
														40	39	36	35	33	32	30	29	27	26	24	21	17	
															38	36	35	34	32	31	29	28	26	24	22	17	
																	36	34	33	31	30	28	27	25	22	17	
																		34	33	32	30	29	27	25	23	18	
																				32	31	29	27	26	23	18	
																						30	28	26	24	19	
																							28	26	24	19	
																								26	24	20	
																									24	20	
																									22	20	
																										20	
																										18	

PURPLE SCALE TABLE—.40 PER CENT LEAKAGE.

Water, ounces.

x3	204	192	180	168	156	144	132	120	114	108	102	96	90	84	78	72	66	60	57	54	51	48	45	42
x2½	170	160	150	140	130	120	110	100	95	90	85	80	75	70	65	60	55	50	47½	45	42½	40	37½	35
x2	136	128	120	112	104	96	88	80	76	72	68	64	60	56	52	48	44	40	38	36	34	32	30	28
x1⅓	90⅔	85⅓	80	74⅔	69⅓	64	58⅔	55⅓	50⅔	48	45⅓	42⅔	40	37⅓	34⅔	32	29½	26⅔	25⅓	24	22⅔	21⅓	20	18⅔

Sodium Cyanide, ounces.

x⅔	45⅓	42⅔	40	37⅓	34⅔	32	29⅓	26⅔	25⅓	24	22⅔	21⅓	20	18⅔	17⅓	16	14⅔	13⅓	12⅔	12	11⅓	10⅔	10	9⅓

Acid and Potassium Cyanide, ounces.

	68	64	60	56	52	48	44	40	38	36	34	32	30	28	26	24	22	20	19	18	17	16	15	14

Dimensions—Distance around and over tent, feet.

	62	61	59	57	55	53	50	48	46	44	43	41	40	38	36	34	32	30	26					
		60	59	58	56	53	51	48	46	45	43	42	40	38	37	35	33	30	27	25				
				58	56	53	51	49	46	45	44	42	40	39	37	35	33	30	27	25				
					56	54	51	49	47	46	44	42	41	39	37	35	33	31	28	26	24			
						54	52	50	47	46	45	43	41	40	38	36	34	31	28	26	24	22		
							52	50	48	46	45	43	42	40	38	36	34	32	28	26	24	22		
								50	48	47	45	44	42	40	39	37	35	33	29	27	25	22	20	
									48	47	46	44	42	41	39	37	35	33	29	27	25	23	20	
											46	44	43	41	40	37	35	33	29	28	26	23	21	18
												44	43	42	40	38	36	33	30	28	26	24	21	19
														42	40	38	36	34	30	28	26	24	21	19
															40	39	37	34	31	29	27	24	22	19
																38	37	34	31	29	27	25	22	20
																	36	35	32	30	28	26	23	20
																		34	32	30	28	26	23	21
																			32	30	29	26	23	21
																				30	29	26	24	21
																					28	27	24	22
																						26	25	22
																							24	23
																								22
																								20

NEW METHOD OF MEASURING TREES.

The use of tables of any kind always introduces the possibility of an error in reading that it would be very desirable to avoid. The fumigator's rule may be used to measure the tree and gives either the dimensions in feet or indicates directly the dose. The method of using the rule for this purpose is shown in figure 3.

This figure is almost self-explanatory—one stands in any position in the orchard, preferably equidistant from two trees, one of which he desires to schedule; holding the rule in the left hand, as shown in position A, bringing it towards the face until the two ends correspond to the trunks of the two trees, then holding the hand perfectly steady, rotate the body slightly till the rule is brought into position B, then grasp it with the right hand in such a way that the thumb will mark off the apparent diameter of the trees; then keeping the rule at exactly the same distance from the eye, turn the hand into positon C; one can read at once on the rule the proper dose corresponding with each degree of leakage. In the figure the circumference of the tree is shown to be 46 feet, the height about 13½ feet; the row of figures between these two points gives the correct dosage for the different degrees of leakage, that is, 4, 5, 6, 7, 9, 11, 13 ounces, according to the different degrees of leakage.

This tree, therefore, represents a seven-ounce dose with average leakage, but may only need four ounces with a tighter tent, or should receive thirteen ounces with the most leaky tent.

The dose is found approximately midway between the two dimensions, or more accurately two fifths of the way from the diameter towards the height.

In case the distance between the trees is more or less than 20 feet the length of the rule should be increased or decreased proportionately since this rule reads to a 20 feet, as shown on the scale on the edge marked diameter.

The rule illustrated is graduated for black scale, the dose for purple scale is approximately twice as large. We propose to produce similar rules for red and purple scale.

This method of measuring trees is sufficiently accurate for practical purposes, and is rapid and convenient and not liable to the errors incident to the use of tables, and may be found better in practice than previous methods.

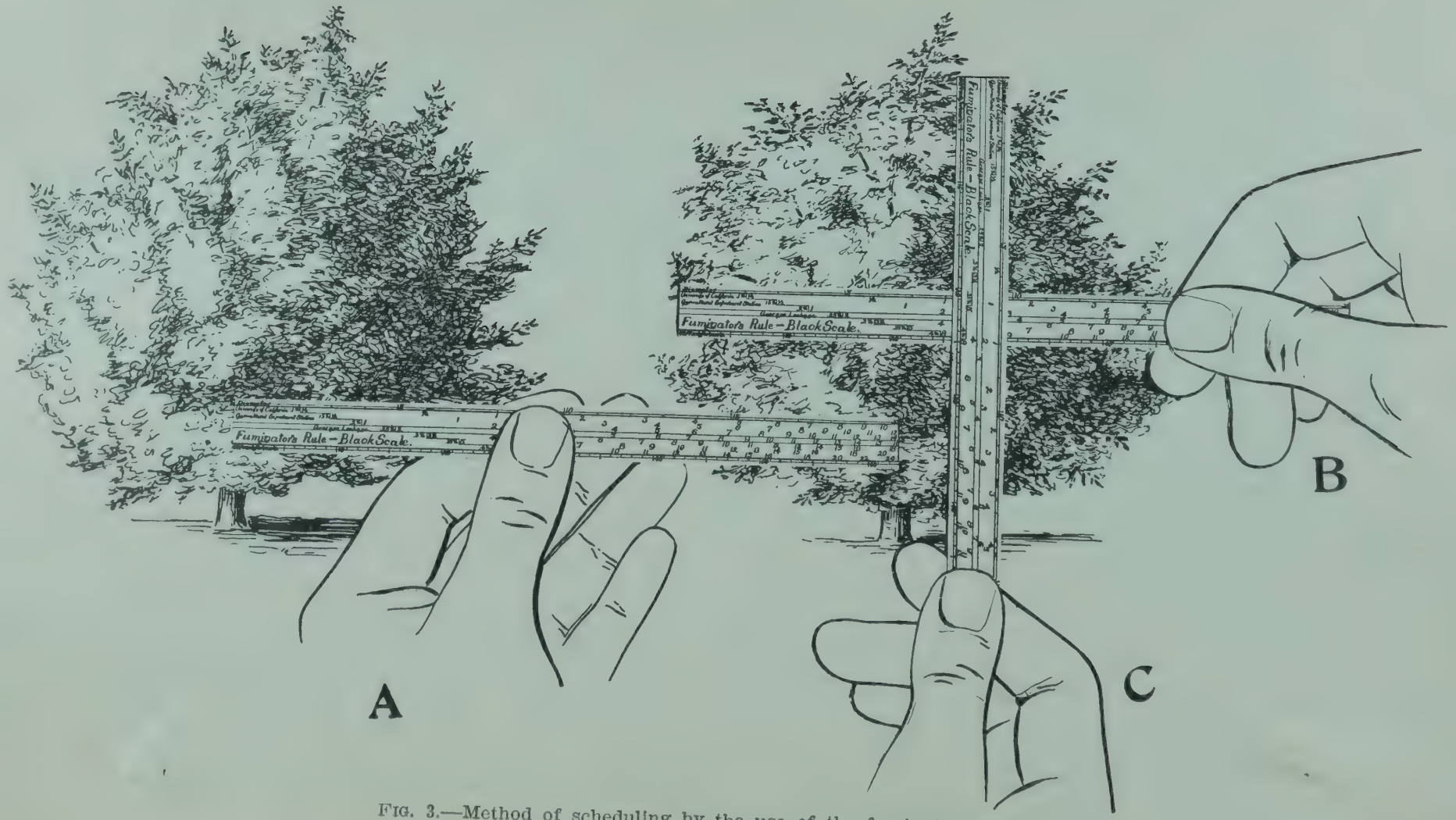


FIG. 3.—Method of scheduling by the use of the fumigator's rule.

RÉSUMÉ.

Recent studies now make possible the proper allowance in the dose for leakage.

Tents differ very greatly in leakage.

Present dosage tables fundamentally wrong.

More uniformity and economy will result from leakage determination.

Excessive dosage now necessary to cover errors in the tables.

Average leakage as determined with doubled tents is .25 per cent.

The common range of leakage was found to be from .10 per cent to .40 per cent.

The dose for black, red, and purple scale for ten-foot tree and with tent having .25 per cent leakage is 4, 5¾, and 7 ounces, respectively.

The dose should be always in this proportion.

Large size or great leakage both require an increased dose.

The proper adjustment to leakage is a complicated problem.

The amount of increase given in the form of a rule showing the whole dosage system.

Small trees require very tight tents.

The limits of effective fumigation are given for all leakages.

This system of dosage agrees with the actual practice of fumigators.

Scheduling charts may be used under this system.

The errors of previous dosage tables are pointed out and a full set of new tables given.

Dosage tables are given for using direct measurements.

A new method is presented which may supersede all other methods of estimating the dose.

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149. California Sugar Industry.
151. Arsenical Insecticides.
153. Spraying with Distillates.
159. Contribution to the Study of Fermentation.
162. Commercial Fertilizers. (Dec. 1, 1904.)
165. Asparagus and Asparagus Rust in California.
167. Manufacture of Dry Wines in Hot Countries.
168. Observations on Some Vine Diseases in Sonoma County.
169. Tolerance of the Sugar Beet for Alkali.
170. Studies in Grasshopper Control.
171. Commercial Fertilizers. (June 30, 1905.)
172. Further Experience in Asparagus Rust Control.
174. A New Wine-cooling Machine.
176. Sugar Beets in the San Joaquin Valley.
177. A New Method of Making Dry Red Wine.
178. Mosquito Control.
179. Commercial Fertilizers. (June, 1906.)
180. Resistant Vineyards.
181. The Selection of Seed-Wheat.
182. Analysis of Paris Green and Lead Arsenic. Proposed Insecticide Law.
183. The California Tussock-moth.
184. Report of the Plant Pathologist to July 1, 1906.
185. Report of Progress in Cereal Investigations.
186. The Oidium of the Vine.
187. Commercial Fertilizers. (January, 1907.)
188. Lining of Ditches and Reservoirs to Prevent Seepage and Losses.
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190. The Brown Rot of the Lemon.
191. California Peach Blight.
192. Insects Injurious to the Vine in California.
193. The Best Wine Grapes for California; Pruning Young Vines; Pruning the Sultanina.
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195. The California Grape Root-worm.
197. Grape Culture in California; Improved Methods of Wine-making; Yeast from California Grapes.
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209. The Cream Supply.
210. Imperial Valley Settlers' Crop Manual.
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217. Honey Plants of California.
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219. Report of Live Stock Conditions in Imperial County, Cal.

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No. 1. Texas Fever.
5. Contagious Abortion in Cows.
7. Remedies for Insects.
9. Asparagus Rust.
11. Fumigation Practice.
12. Silk Culture.
15. Recent Problems in Agriculture. What a University Farm is For.
19. Disinfection of Stables.
29. Preliminary Announcement Concerning Instruction in Practical Agriculture upon the University Farm, Davis, Cal.
30. White Fly in California.
32. White Fly Eradication.
33. Packing Prunes in Cans. Cane Sugar vs. Beet Sugar.
36. Analyses of Fertilizers for Consumers.
39. Instruction in Practical Agriculture at the University Farm.
46. Suggestions for Garden Work in California Schools.
48. Butter Scoring Contest, 1909.
49. Insecticides.
50. Fumigation Scheduling.
No. 52. Information for Students Concerning the College of Agriculture.
54. Some Creamery Problems and Tests.
55. Farmers' Institutes and University Extension in Agriculture.
58. Experiments with Plants and Soils in Laboratory, Garden, and Field.
59. Tree Growing in the Public Schools.
60. Butter Scoring Contest, 1910.
61. University Farm School.
62. The School Garden in the Course of Study.
63. How to Make an Observation Hive.
64. Announcement of Farmers' Short Courses for 1911.
65. California Insecticide Law.
66. Insecticides and Insect Control.
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69. The Extermination of Morning-glory.
70. Observations on Status of Corn-growing in California.

BUREAU OF ECONOMIC BOTANY, GOVERNMENT BOTANICAL GARDENS
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COMMERCIAL FERTILIZERS

By JOHN S. BURD

BULLETIN No. 221

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COMMERCIAL FERTILIZERS.

By JOHN S. BURD.

The most important question that has arisen during the past year in connection with the work of the Fertilizer Control has been in the matter of the adjustment of prices of fertilizer ingredients. It has always been the practice to issue a schedule of trade values of all of the standard ingredients used in commercial fertilizers. The primary purpose of such a schedule is, as has been repeatedly pointed out, to serve as a basis for estimating the extent to which any given fertilizer conforms to or deviates from the manufacturer's guaranty. The necessity for some such basis is at once apparent when we consider that most fertilizers contain more than one ingredient and that in many cases some ingredients are present in greater amounts and the remainder in lesser amounts than the manufacturer claims. Under such circumstances the analysis alone is insufficient to show whether or not the manufacturer has substantially complied with his guaranty. To take a concrete case, a manufacturer guarantees a tankage to contain certain percentages of phosphoric acid and nitrogen and it is found on analysis to contain different quantities.

Thus:—

	Guaranteed.	Found by analysis.
Phosphoric Acid	10%	12%
Nitrogen	8%	7%

Comparing the two it is seen that the manufacturer has supplied 2 per cent more phosphoric acid and 1 per cent less nitrogen than he promised, but unless some common standard is used as the commercial value, it is impossible to say whether the buyer or the seller has gained by the substitution. Applying such a standard and assuming a value of 4 cents a pound or 80 cents a unit for phosphoric acid and 20 cents a pound or $4.00 a unit for nitrogen,

	Guaranteed.	Found by analysis.
Phosphoric Acid	10% × $0.80 = $ 8.00	12% × $0.80 = $ 9.60
Nitrogen	8% × 4.00 = 32.00	7% × 4.00 = 28.00
Value per ton	$40.00	$37.60

It is at once evident that the manufacturer has supplied goods which are in reality worth less by (\$40.00—\$37.60) \$2.40 than he guaranteed. The purchaser thus learns that he has lost \$2.40 per ton by the transaction and he can use the figure so obtained as a basis for a claim against the seller. Or prospective purchasers, by consulting the published analyses, can learn of the extent to which the various manufacturers are in the habit of complying with their guaranties, and form a rational opinion as to their several degrees of reliability.

Now for the present purpose it makes very little difference whether the prices assumed are the exact market prices or not. Thus, using a different price for nitrogen and applying as above,

	Guaranteed.	Found by analysis.
Phosphoric Acid	10% × \$0.80 = \$ 8.00	12% × \$0.80 = \$ 9.60
Nitrogen	8% × 4.40 = 35.20	7% × 4.40 = 30.80
Value per ton	\$43.20	\$40.40

there is a difference of (\$43.20—\$40.40) \$2.80 in the calculated values, as against \$2.40 when the lesser price for nitrogen was used. In other words, a considerable error in setting the price of nitrogen would make comparatively little difference (40 cents) in calculating the gain or loss of value due to the variation in composition of the fertilizer from the guaranty.

If, however, the values of goods supplied at the first prices are compared with those supplied at the second prices, it is at once evident that there is quite a difference (\$40.40—\$37.60), \$2.40, due to estimating nitrogen at 20 cents instead of 22 cents per pound. If 22 cents is the correct market price the use of the incorrect price makes it appear that the seller is defrauding the purchaser ot \$2.40 per ton when in fact he is not. These illustrations will perhaps serve to show the value arising to the public from the proper use of a schedule of approximate market prices, but they also indicate the limitations of the method where the prices used are not exact market prices.

It has been repeatedly pointed out in our publications and correspondence that the schedule of prices adopted by the Fertilizer Control cannot be exact market prices. This is so, if for no other reason, because the prices are adopted in advance of their use and the fluctuations of the fertilizer market cannot be anticipated. Notwithstanding the efforts to make this matter clear, there has been considerable friction between sellers and buyers of fertilizers because the latter have in many cases *assumed* that the prices heretofore issued were the

prices at which they could expect to buy. These misunderstandings have been especially numerous during the past year because the prices in the recent schedule were in general rather low, it being considered preferable to make the prices low (by leaving out certain incidental charges) than to lead the consumer to believe that he ought to pay more for his fertilizers.

The matter of estimating the cost of fertilizer ingredients is a difficult one in this State because there are no published local quotations such as are to be had in large markets like New York City. In the absence of local quotations it is necessary to take the quotations that are available and by reasonable allowances for freight approximate the local prices. In the case of certain commodities such a method is not applicable and the estimates of local manufacturers have to be used. Bare prices arrived at as above without incidental costs are the ones that have been used heretofore, including the schedule announced in July, 1910, by which all the values in the present bulletin are calculated. The misunderstandings resulting from using the bare market prices in the schedule have induced the attempt to more nearly approximate the costs to the manufacturer in the schedule now being issued for the coming year. The present schedule, then, instead of being the bare market quotations, as heretofore, is supposed to represent the recent market prices plus interest, insurance, handling, and storage. Or, according to the trade term, to be the cost ex-warehouse of the local manufacturer or dealer rather than the cost ex-railroad or ex-ship.

It has further been deemed advisable to drop the practice of setting or using a price for insoluble phosphoric acid, owing to the

CORRECTION SLIP FOR BULLETIN 221

On page 36, in lines 14 and 17 from foot of page,

for \$2.40, *read* \$2.80.

plant food.

SCHEDULE OF TRADE VALUES, 1911–1912.

	Cents per pound.	Value per unit.
Nitrogen from blood	23.6	$4.72
Nitrogen from tankage and bone	22.8	4.56
Nitrogen from ammonia sulfate	17.9	3.58
Nitrogen from nitrate of soda	14.1	2.82
Phosphoric Acid from tankage	3.8	0.76
Phosphoric Acid from bone (high in Phosphoric Acid, low in Nitrogen)	5.0	1.00
Phosphoric Acid from bone (low in Phosphoric Acid, high in Nitrogen)	4.6	0.92
Phosphoric Acid from bone and superphosphate	5.0	1.00
Available Phosphoric Acid from rock superphosphate	4.7	0.94
Phosphoric Acid from Thomas Phosphate Powder	4.2	0.84
Potash from Sulfate of Potash	5.7	1.14
Potash from Muriate of Potash	4.9	0.98

The base prices from which the above schedule is deduced are obtained as follows:
Blood and Tankage, Chicago market quotations and freight to Pacific Coast terminals.
Bone Meal, California manufacturers' estimates.
Sulfate of Ammonia, New York quotations and a differential freight rate based on Chicago production and delivery to California terminals.
Nitrate of Soda, California manufacturers' estimates and actual sales.
Potash Salts, New York quotations and differential freight rate (by sea) to California points.
Bone Superphosphate, local manufacturers' estimates.
Thomas Phosphate Powder, local manufacturers' estimates.
Rock Superphosphates, factory price, San Francisco Bay, and freight to Southern California points.

CAUTION TO FERTILIZER CONSUMERS.

It cannot be too frequently pointed out that the commercial value and the agricultural value of fertilizers is in no way related. The choice of the kind of plant food to be purchased should be based on a knowledge of the needs of the particular crop and soil to be treated. Only after this is decided should the cost of the fertilizer be considered, when the particular kind of fertilizer supplying the ingredient desired should be selected according to its agricultural availability and cost.

The elimination from the schedule of estimates of the commercial value of insoluble phosphoric acid and of fine and medium bone and tankage make it necessary that consumers pay particular attention in the analytical reports to the figures for availability and fineness. Heretofore the use of such valuations has reflected the inferiority of goods of low availability and fineness in the calculated value per ton. This is not the case under the present schedule, hence the importance of buying and insisting on receiving goods of high availability and degree of fineness.

REGISTERED MANUFACTURERS AND DEALERS.

The present bulletin comprises the results of the fertilizer inspection work of the California Fertilizer Control for the fiscal year ending June 30, 1911.

The following manufacturers and dealers in commercial fertilizers have obtained certificates of registration under the provisions of the California Fertilizer law, for the fiscal year beginning July 1, 1910. A list is also given of the brands of fertilizers and fertilizer materials offered by them for sale. According to the sworn returns of dealers registered for the fiscal year ending June 30, 1910, their entire sales in the state amounted to 36,634 tons. Nearly complete returns for the year ending June 30, 1911, indicate sales of 46,000 tons.

No dealer or manufacturer, except those who have certificates of registration from the University of California, and their authorized agents, can legally sell fertilizers in this State. No person or company has any right to use any registration number except in connection with the firm name to which the registration certificate of such number has been issued; and no person or company to whom a registration number has been assigned has any right to give any other person or company permission to use said registration number, and any number so used is a fraud. No agent has any right to use his principal's registration number in connection with his own name.

Agricultural Chemical Works, Los Angeles, Cal.

Registration No. 8.

Apricot.
Bat Guano.
Bat Guano and Bone.
Bat Guano and Gypsum.
Blood.
Bone Meal.
Brands A, B, C, D, E, F, G, H, J, K, L, M, and N.
Grape and Berry.
Gypsum.
Lawn and Rose.
Muriate of Potash.
Nitrate of Soda.
Nursery.
Olive.
Potato.
Prune and Peach.
Sulfate of Ammonia.
Sulfate of Potash.
Summer, A, B, and C.
Superphosphate.
Tankage.
Vegetable.
Walnut and Almond.

Special mixtures to order of consumers.

American Agricultural Chemical Co., California Works, Los Angeles, Cal.

Registration No. 1.

Bradley's Acid Phosphate.
Bradley's Grain, No. I.
Bradley's Grain, No. II.
Bradley's Fruit and Vine.
Bradley's Lawn.
Bradley's Lemon Tree.
Bradley's Nursery Stock.
Bradley's Orange and Lemon.
Bradley's Special Nursery Stock.
Nitrate of Soda.
Sulfate of Ammonia.
Sulfate of Potash.
Special Brands to Order.
Vegetable.

Arlington Heights Fruit Co., Riverside, Cal.

Registration No. 48.

Acid Phosphate.
Basic Slag.
Bat Guano.
Blood.
Bone.
Fish Guano.
Nitrate of Soda.
Sulfate of Potash.
Tankage.
Whale Blood.
Whale Bone.

The Armour Fertilizer Works, Los Angeles, Cal.

Registration No. 7.

Bone Meal.
Bone, Blood and Potash.
Dried Blood.
Flower and Fern Food.
Fruit Special.
Fruit and Vine.
Guano.
Lawn and Garden Fertilizer.
Lawn Special.
Nitrate of Soda.
Orange Tree Manure.
Special 5-8-2.
Sulphate of Potash.
Superphosphate.
Tankage.

Special mixtures to order of consumers.

Balfour, Guthrie & Co., San Francisco, Cal.

Registration No. 10.

Nitrate of Soda.
Sulfate of Potash.
Muriate of Potash.
Thomas Phosphate Powder.

Braun Chemical Co., Los Angeles, Cal.

Registration No. 35.

Acid Phosphate.
Muriate of Potash.
Nitrate of Soda.
Sulfate of Ammonia.
Sulfate of Potash.
Superphosphate.

California Fertilizer Works, Inc., San Francisco, Cal.

Registration No. 3.

Fruit and Vine.
Fruit, Orange and Vine.
High Grade Bone and Blood Superphosphates.
Nursery Stock.
Odorless Lawn Dressing.
Orange Tree (B).
Special Bone and Blood Meal.
Special Orange Tree.
Special Orange (A).
Special Orange Tree, yellow leaves.
Peach.
Special Fertilizer with Iron Sulfate
Special Fertilizer.
Special Fruit and Vine.
Special Orange and Lemon.
Special Nursery Stock.
Special Phosphate and Potash.
Truck and Berry.

California Ranch Supply and Fertilizer Exchange, Upland, Cal.

Registration No. 50.

Blood.
Bone Meal.
Double Manure Salt.
Fish Guano.
Guano.
Nitrate of Soda.
Sulfate of Potash.
Superphosphate.
Sulfate of Ammonia.
Sulfate of Iron.
Thomas Phosphate Powder.

Special mixtures to order of consumers.

Carlsbad Guano and Fertilizer Co., Redlands, Cal.

Registration No. 47.

Bat Guano.
Blood.
Bone Meal.
Nitrate of Soda.
Sulfate of Potash.
Superphosphate.
Tankage.
Mutual, No. 1.

Special mixtures to order of consumers.

Cudahy Packing Co., South Omaha, Neb.

Registration No. 16.

Tankage, otherwise designated Blood and Bone.

General Fertilizer Association, Los Angeles, Cal.,

Registration No. 42.

G. F. A. Special.
G. F. A. Special, No. 2.
G. F. A. No. 3.
G. F. A. No. 4.
G. F. A. No. 5, Exchange Brand.
G. F. A. No. 6.
G. F. A. No. 8.
G. F. A. Root and Tuber.
Lindsay Special.
Orange and Lemon, No. 1.

The Hauser Packing Co., Los Angeles, Cal.

Registration No. 33.

Bone Meal.
Dried Blood.
Ground Tankage.
Special.

Hawaiian Fertilizer Co., Ltd., San Francisco, Cal.

Registration No. 19.

Alfalfa.
Blood.
Bone Meal.
Fish Guano.
Fruit and Vine.
Muriate of Potash.
Nitrate of Soda.
Nursery Stock.
Orange and Lemon.
Sulfate of Potash.
Superphosphate.
Thomas Phosphate.
Tankage.

Special mixtures to order of consumers.

Simon Levy, Los Angeles, Cal.

Registration No. 37.

Sheep Manure.

Thomas Lewis, Sacramento, Cal.

Registration No. 40.

The Tom Lewis Fertilizer.

Los Angeles Fertilizer Co., Los Angeles, Cal.

Registration No. 38.

Animal Bone and Potash.
Fruit Grower.
Fruitmore
Garden and Lawn.
Growmore
Hanson's Odorless.
L. A. Bone Meal.
Nitrate of Soda.
Orangaid.
Special.
Special Fruit Grower.
Spring Special.
Sulfate of Potash.
Superphosphate.
Tankage.
T. & P.

Mapes Formula and Peruvian Guano Co., New York.

J. J. Prendergast, Redlands, Agent.

Registration No. 12.

Mapes Fruit and Vine Manure.
Mapes Vegetable Manure.
Mapes Orange Tree Manure.

Morris & Co., Chicago.

W. B. Burr, 307 Central Bldg., Los Angeles, Agent.

Registration No. 26.

Pacific Big One.
Pacific Big Two.
Pacific Big Three.
Pacific Big Four.
Pacific Big Five.
Pacific Big Six.
Pacific Big Seven.
Pacific Big Eight.
Ground High Grade Blood.

The Mountain Copper Co., San Francisco, Cal.

Registration No. 28.

Mococo. Superphosphates.
Mococo. Mixed Fertilizers of various compositions.
Nitrate of Soda.
Sulphate of Potash.

Special mixtures to order of consumers.

Nitrate Agencies Co., Los Angeles, Cal.

Registration No. 45.

Nitrate of Soda.
Imported Bone Flour.
Sulfate of Potash.

Oakland Meat and Packing Co., Stock Yards, Cal.

Registration No. 24.

Special Fertilizer.

Pacific Bone, Coal and Fertilizing Co., San Francisco, Cal.

Registration No. 14.

Bone Meal.
Ceres Brand.
Ceres Brand No. 0.
Ceres Brand No. 1.
Ceres Brand No. 2.
Citrona Brand.
Citrona Brand No. 1.
Citrona Brand No. 2.
"Flora" Brand.
Lupine Brand.
Muriate of Potash.
Nitrate of Soda.
Pomona Brand.
Pomona Brand No. 1.
Pomona Brand No. 2.
Pure Dissolved Bone Meal.
Sulfate of Potash.
Superphosphates.
Tankage
Thomas Phosphate Powder.

Special mixtures to order of consumers.

Pacific Guano and Fertilizer Co., San Francisco, Cal.

Registration No. 4.

Dissolved Bone Superphosphate.
Raw Bone Meal.
Steamed Bone Meal.
Double Manure Salt.
Dried Blood.
Fish Scrap.
(F) Fruit and Vine.
Kainit.
(B) Lawn Dressing.
Muriate of Potash.
Nitrate of Soda.
(N) Nursery Stock.
Special 8-6-2.
(PP) Special Phosphate and Potash.
Sulfate of Ammonia.
Sulfate of Potash.
Superphosphate.
Double Superphosphate.
Tankage.
Thomas Phosphate Powder.
Basic Superphosphate No. 1 Cresco.
Basic Superphosphate No. 2 Cresco.
(GG) Grain Grower.
(PNK) Phosphorous, Nitrogen and Kalium.
Standard Acid Phosphate "Cresco."
(T) Truck.
West Coast Fertilizer.
West Coast Lawn Dressing.

Special mixtures to order of consumers.

Pacific Wood and Coal Co., San Diego, Cal.

Registration No. 53.

(BG) Complete.
(BG) Lawn.
(BG) Sail Regulator.
(BG) Tree Tonic.
Nitrate of Soda.
Sulfate of Potash.
Superphosphate.

R. & M. Company, San Francisco, Cal.

Registration No. 54.

Sana Vita No. 1.
Sana Vita No. 2.

Redlands Fertilizer Association, Redlands, Cal.

Registration No. 49.

Bat Guano.
Bone Meal.
Dried Blood.
Nitrate of Soda.
Nitrate of Lime.
Sulfate of Potash.
Tankage.

Special mixtures to order of consumers.

Redlands Fruit Association, Redlands, Cal.

Registration No. 34.

Bone Meal.
Dried Blood.
Fish Scrap.
Nitrate of Soda.
Sulfate of Potash.
Superphosphate.
Tankage.

San Bernardino Fertilizer Works, San Bernardino, Cal.

Registration No. 15.

Bone Meal.
Lawn Fertilizer.
Nitrate of Soda.
Nursery Fertilizer.
Orange and Lemon, No. 1.
Special Orange.
Sulfate of Potash.

Special mixtures to order of consumers.

Southern California Fertilizer Co., Los Angeles, Cal.

Registration No. 42.

Bone Meal.
Southern California Orange.
Southern California Orange and Lemon.
Southern California Orange Special.
Southern California Standard.
Southern California "A" Special.
Southern California "B" Special.
Southern California Fruit and Vine.
Southern California Peach and Apricot.
Southern California Root and Tuber.
Southern California Pea and Vetch.
Southern California Root and Tuber.
Southern California Lawn and Nursery.
Southern California Fruit Special.
Southern California Fruit Special A.
Southern California Fruit Special B.
Guano.
Nitrate of Soda.
Sulfate of Potash.
Tankage.

Special mixtures to order of consumers.

Standard Rendering Co., Kansas City, Mo.

Registration No. 44.

Standard One.
Standard Two.
Standard Three.
Standard Four.
Standard Concentrated.
Standard Bone.

Swift & Co., Chicago, Ill.

Registration No. 5.

Swift's Diamond "C" Fertilizer.
Swift's Diamond "D" Fertilizer.
Swift's Diamond "E" Fertilizer.
Swift's Diamond "K" Fertilizer.
Swift's Diamond "L" Fertilizer.
Swift's Diamond "M" Fertilizer.
Swift's Ground Blood.
Swift's Acidulated Bone Meal.
Swift's Special Bone Meal.
Swift's High Grade Tankage.

Union Fertilizer Co., Los Angeles, Cal.

Registration No. 9.

Acidulated Bone.
Blood.
Bone Meal.
Fruiting Fertilizer.
Bat Guano.
Bird Guano.
Nitrate of Soda.
Nursery or Spring Fertilizer.
Special Fruiting.
Sulfate of Potash.
Superphosphate.
Tankage.

Special fertilizers to order of consumers.

Union Meat Company, North Portland, Oregon.

Registration No. 55.

A Special.
Diamond A.
Diamond B.
Diamond C.
Diamond D.

Union Superphosphate Co., San Francisco, Cal.

Registration No. 31.

Cresco-Basic Superphosphate No. 1.
Cresco-Basic Superphosphate No. 2.
Cresco-Superphosphate.

Western Meat Company, San Francisco, Cal.

Registration No. 11.

Gold Bear A.
Gold Bear B.
Gold Bear C.
Gold Bear D.
Gold Bear E Tankage.
Gold Bear F Raw Bone Meal.
Gold Bear Steamed Bone Meal.
Gold Bear H Pure Blood Meal.

Woodbridge Fertilizer Co., Los Angeles Cal.

Registration No. 22.

Bone Meal.
Nitrate of Soda.
Muriate of Potash.
Orange.
Lemon.
Sulfate of Potash.
Tankage.

SCOPE OF INSPECTION.

During the year 712 samples of fertilizers and fertilizing materials have been received at the laboratory. Of this number 39 were sent by farmers under the two-dollar fee provision, 269 were taken by inspectors from purchasers' goods upon the request of the purchasers, and 286 were taken by inspectors from goods in the hands of agents and manufacturers. On 47* samples the analysis as reported was used as a basis of settlement by mutual agreement of buyer and seller. No guaranty was required or given with goods sold under such agreement. Seventy-one samples of a miscellaneous nature are omitted from the tables.

The following classification may be made of samples reported in this bulletin:

Complete Fertilizers	293
Bone Meal	47
Tankage	134
Superphosphates	43
Double Superphosphates	3
Dried Blood	30
Nitrate of Soda	31
Sulfate of Potash	17
Bat Guano	22
Bird Guano Phosphate	1
Superphosphate and Potash	7
Thomas Phosphate Powder	5
Sulfate of Ammonia	4
Fish Guano	1
Miscellaneous	3
Total	641

DEFICIENCIES.

In the analyses of the above samples, the following number of deficiencies greater than that allowed by law occurred:

Available Phosphoric Acid (total when available is not guaranteed)	32
Total Nitrogen	52
Potash	17
In valuation	23

These deficiencies were found in 95 samples.

The fertilizer law allows a deficiency of 0.25 per cent in nitrogen, 0.50 per cent in potash, and 1 per cent in available phosphoric acid.

* Besides these a considerable number of the remaining purchasers' analyses were doubtless used subsequently as a basis of settlement, but without being reported to this office.

SCHEDULE OF TRADE VALUES, 1910–1911.

	Cents per pound.	Value per unit.
Phosphoric Acid.		
Available (water and citrate-soluble)	5	$1.00
Insoluble in mixed fertilizers	2	.40
In fine* bone and tankage	3½	.70
In medium* bone and tankage	3	.60
Nitrogen.		
In ammonia salts	14	2.80
In nitrates	13½	2.70
Organic in—		
Blood	21	4.20
Mixed fertilizers	20	4.00
Fine* bone and tankage	20½	4.10
Medium* bone and tankage	16	3.20
Potash.		
From sulfate	5	1.00
From muriate	4	.80

REPORT OF ANALYSES.

Available phosphoric acid is not determined in bone meal, tankage, and Thomas phosphate powder, unless requested. The fineness of these materials is determined, fine and medium bone being separated by a sieve of 50 meshes to the inch; tankage by a 25-mesh sieve; and Thomas phosphate powder by a 100-mesh sieve.

Nitrogen in ammonia salts will, in some cases, be found reported when nitrogen in this form is not guaranteed. In some of such cases this form of nitrogen is produced by conversion of organic nitrogen during process of manufacture, and is not to be considered a deviation from guaranty of materials used. Guanos carry more or less nitrogen in nitrates and ammonia salts, and when any appreciable quantity of guano is used the manufacturer should take into account the fact that some nitrogen will show as nitrates and ammonia salts. The failure to take this into consideration may perhaps account for the appearance of these forms of nitrogen in some samples in which only organic nitrogen was guaranteed.

The percentage of chlorin is given when it exceeds 0.50 per cent. It is a matter of only technical interest whether chlorin present is from muriate of potash, kainit, or from common salt that may be in some of the materials used. If a manufacturer uses sulfate of potash and uses a tankage with it containing a large amount of chlorin, from

* Fine and medium bone are separated by a sieve with 50 meshes to the inch; fine and medium tankage by a 25-mesh sieve; and fine and medium Thomas phosphate powder by a 100-mesh sieve.

a practical standpoint he has lowered the grade of his fertilizer just as much as if he had used muriate of potash instead of sulfate of potash. Chlorin from all other sources is as objectionable as from muriate of potash. However, if muriate of potash is found when sulfate is guaranteed, the fact will be published.

The following abbreviations are used in the tables: Bl = blood, Bn = bone, Fs = fish, G = guano, Super = superphosphates, T = tankage, H = hoof, Min. Phos. = mineral phosphate.

Guarantees are entered in *italics*. Deficiencies greater than allowed by law are entered in bold type.

ANALYSES AND VALUATIONS.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Agricultural Chemical Works, Los Angeles, Cal.		
3273	"A"	J. E. Morrow, Upland	$24.47
	Guaranteed		*22.60*
3167	Almond	P. M. Davis, Banning	22.46
	Guaranteed		*21.50*
3166	Apricot	P. M. Davis, Banning	25.26
	Guaranteed		*22.70*
3184	"B"	W. H. Collins, Covina	26.30
3263	"B"	Thomas Moffat, Rialto	26.64
3307	"B"	J. M. Webster, Upland	26.92
	Guaranteed		*25.00*
3180	Bat Guano	W. H. Collins, Covina	35.27
	Guaranteed		*36.73*
3318	Bat Guano	H. Waterman, Upland	**29.80**
	Guaranteed		*34.70*
3397	Bat Guano	Glendora Citrus Assn., Glendora	22.45
	Guaranteed		*24.00*
3398	Bat Guano	Glendora Citrus Assn., Glendora	42.13
	Guaranteed		*44.50*
2927	Bat Guano Special	G. A. Herdeg, Riverside	**34.81**
3217*	Bat Guano Special	G. A. Herdeg, Riverside	37.13
	Guaranteed		*41.90*
2942*	Blood	G. A. Herdeg, Riverside	58.08
3319*	Blood	J. M. Webster, Upland	57.54
	Guaranteed		*56.28*
3264*	Bone Meal	Thomas Moffat, Rialto	28.34
	Guaranteed		*24.44*
3317*	Bone Flour	E. B. Clark, Upland	26.30
	Guaranteed		*25.06*
3389*	Bone Flour	Mrs. A. M. Maddock, Duarte	26.29
	Guaranteed		*23.68*
3179	"C"	W. H. Collins, Covina	28.71
3216	"C"	G. A. Herdeg, Riverside	30.62
3272	"C"	Wm. Springer, Upland	28.82
3465	"C"	R. H. Cochrane, Redlands	28.52
	Guaranteed		*27.70*
3218	"E"	G. A. Herdeg, Riverside	30.20
	Guaranteed		*28.00*
3178	"F"	W. H. Collins, Covina	22.05
	Guaranteed		*21.50*
2961*	Fish Guano	E. A. Moore, Redlands	37.61
	Guaranteed		*37.24*

*3217—Discrepancy in valuation due to inadequacy of guaranty.

*2942—Some hoof.

*3319—Some hoof.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3273	5.83	2.82	8.65	*Super, T*	1.57	0.20	2.35	*Bat G, Bl, Bn*	4.12	3.32	3.32	1.10
	5.00	*3.00*	*8.00*		*2.00*	.....	*2.00*		*4.00*	*3.00*	*3.00*	.....
3167	**4.72**	3.77	8.49		0.23	0.25	2.70		3.18	4.11	4.11	.....
	6.00	*2.00*	*8.00*		*1.00*	.....	*2.00*		*3.00*	*4.00*	*4.00*	.....
3166	6.20	4.30	10.50		.....	0.17	2.83		3.00	5.54	5.54	.....
	5.00	*5.00*	*10.00*		*1.00*	.....	*2.00*		*3.00*	*5.00*	*5.00*	.....
3184	5.34	3.16	8.50		2.22	0.16	2.72		5.10	2.37	2.37	.....
3263	4.88	3.02	7.90		2.21	0.20	2.82		5.23	2.74	2.74	.....
3307	6.45	1.70	8.15		2.36	0.20	2.56		5.12	2.62	2.62	1.07
	4.00	*4.00*	*8.00*		*2.00*	.....	*3.00*		*5.00*	*2.00*	*2.00*	.....
3180	.....	.....	5.20	.....	1.66	1.09	5.65	.....	8.40	.....	1.50	.....
.....	.....	.....	*5.36*	.....	.....	.....	*7.76*	.....	*7.76*	.....	*1.94*	.....
3318	.....	.....	6.40	.....	1.27	0.90	3.98	.....	**6.15**	.....	3.45	.....
.....	.....	.....	*6.00*	.....	.....	.....	*7.00*	.....	*7.00*	.....	*2.50*	.....
3397	.....	.....	5.50	.....	1.05	0.55	3.03	.....	4.63	.....	2.08	
.....	.....	.....	*5.00*	.....	.....	.....	*4.75*	.....	*4.75*	.....	*1.50*	.....
3390	.....	.....	5.05	.....	1.14	1.47	7.30	.....	9.91	.....	2.22	.....
.....	.....	.....	*5.00*	.....	.....	.....	*9.75*	.....	*9.75*	.....	*2.00*	.....
2927	.....	.....	6.00	.....	4.34	0.85	3.86	.....	**9.05**	.....	1.08	.....
3217	.....	.....	5.50	.....	5.72	0.62	3.70	.....	10.04	.....	1.30	.....
.....	.....	.....	*5.00*	*Bat G*	*2.00*	.....	*8.00*	*Bat G, Bl*	*10.00*	.....	*1.00*	.....
2942	.....	.....	.....	.....	.....	.....	13.83	.....	13.83	.....	.....	.....
3319	.....	.....	.....	.....	.....	.....	13.70	.....	13.70	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.40*	.....	*13.40*	.....	.....	.....
3264	.....	.....	20.50	.....	.....	.....	4.02	.....	4.02	.....	.....	.....
.....	.....	.....	*20.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
3317	.....	.....	32.30	.....	.....	.....	0.91	.....	0.91	.....	.....	.....
.....	.....	.....	*30.00*	.....	.....	.....	*1.00*	.....	*1.00*	.....	.....	.....
3389	.....	.....	32.60	.....	.....	.....	0.85	.....	0.85	.....	.....	.....
.....	.....	.....	*28.00*	.....	.....	.....	*1.00*	.....	*1.00*	.....	.....	.....
3179	4.53	4.32	8.85	.....	2.47	0.22	3.16	.....	5.85	2.52	2.52	.....
3216	4.90	3.70	8.60	.....	2.65	0.20	3.48	.....	6.33	2.60	2.60	.....
3272	6.00	2.60	8.60	.....	2.91	0.20	2.79	.....	5.90	2.21	2.21	1.20
3465	4.06	4.04	8.10	.....	2.35	.....	3.56	.....	5.91	2.26	2.26	1.00
.....	*4.00*	*4.00*	*8.00*	*Super, Bn, T*	*3.00*	.....	*3.00*	*Bat G, Bl, Bn*	*6.00*	*2.00*	*2.00*	.....
3218	5.15	3.40	8.55	.....	1.57	0.20	3.42	.....	5.19	5.21	5.21	.....
.....	*4.00*	*4.00*	*8.00*	*Super, T*	*2.00*	.....	*3.00*	*Bl, Bn*	*5.00*	*5.00*	*5.00*	.....
3178	5.34	3.96	9.30	.....	1.09	0.12	1.95	.....	3.16	4.06	4.06	.....
.....	*6.00*	*2.00*	*8.00*	*Super, T*	*1.00*	.....	*2.00*	*Bat G, Bl, Bn*	*3.00*	*4.00*	*4.00*	.....
2961	.....	.....	7.15	.....	.....	.....	8.72	.....	8.72	.....	.....	.....
.....	.....	.....	*7.25*	.....	.....	.....	*8.60*	.....	*8.60*	.....	.....	.....

*3264—32% fine.
*3317—96% fine.
*3389—98% fine.
*2961—61% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Agricultural Fertilizer Works— *Continued.*		
3165	"K"	Gowen & Willard, Santa Ana	22.86
3320	"K"	J. M. Webster, Upland	23.69
3466	"K"	G. W. Neuls, Redlands	23.73
	Guaranteed		*23.00*
3342	"N"	W. W. Phipps, Upland	28.41
3370	"N"	H. E. Winslow, Rialto	28.94
	Guaranteed		*30.90*
3411	"N"	Dr. Raymond Ludden, Colton	28.18
3583	"N"	Thomas Moffat, Rialto	29.34
	Guaranteed		*29.60*
2963	Nitrate of Soda	E. A. Moore, Redlands	42.28
3164	Nitrate of Soda	Gowen & Willard, Santa Ana	42.06
3219	Nitrate of Soda	G. A. Herdeg, Riverside	42.74
3327	Nitrate of Soda	J. M. Webster, Upland	42.74
	Guaranteed		*40.50*
3168	Peach and Prune	P. M. Davis, Banning	22.08
	Guaranteed		*21.50*
3183	Special	W. H. Collins, Covina	31.57
	Guaranteed		*30.90*
3378	Special	D.C. Mulock, Alhambra	25.19
	Guaranteed		*25.10*
3415	Special	Dr. E. W. Burke, Highland	26.04
	Guaranteed		*25.80*
3536	Special	W. B. Gregor, Colton	26.43
	Guaranteed		*29.70*
3560	Special	G. A. Herdeg, Riverside	29.54
	Guaranteed		*27.20*
3193	Special Lawn	Germain Seed & Plant Co., Los Angeles	14.97
	Guaranteed		*13.10*
2937	Special Orange and Lemon	G. A. Herdeg, Riverside	28.76
	Guaranteed		*28.00*
2938	Special Orange and Lemon	G. A. Herdeg, Riverside	29.95
	Guaranteed		*27.70*
2957	Special Orange and Lemon	E. A. Moore, Redlands	27.83
	Guaranteed		*27.60*
2958	Special Orange and Lemon	E. A. Moore, Redlands	24.59
3100	Special Orange and Lemon	H. S. Dalrymple ,Fullerton	24.09
	Guaranteed		*23.00*
2962	Special Orange and Lemon	E. A. Moore, Redlands	22.45
	Guaranteed		*22.20*
2964	Special Orange and Lemon	E. A. Moore, Redlands	23.89
	Guaranteed		*22.60*
3306	Superphosphate	H. D. Derwin, Upland	.....
3561	Superphosphate	H. D. Derwin, Upland	.....
	Sold on Station Analysis.		
2939	Superphosphate	G. A. Herdeg, Riverside	18.72
	Guaranteed		*18.09*

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3165	5.85	4.70	10.55	*Super, Bn, T*	1.80	.....	1.96	*Bat G, Bl, Bn*	3.76	2.43	2.43	.....
3320	5.90	4.40	10.30		1.32	0.11	2.54		3.97	2.00	2.00	1.00
3466	6.16	4.34	10.50		1.04	0.11	2.63		3.78	2.19	2.19	.....
.....	*6.00*	*4.00*	*10.00*		*2.00*	.....	*2.00*		*4.00*	*2.00*	*2.00*	.....
3342	7.04	2.96	10.00		3.13	.....	1.77		4.90	4.66	4.66	.....
3370	7.44	2.96	10.40		3.40	.....	1.50		4.90	5.14	5.14	.....
.....	*7.50*	*2.50*	*10.00*		*2.00*	.....	*3.00*		*5.00*	*5.00*	*5.00*	.....
3411	**6.35**	4.50	10.85		2.63	.....	2.01		**4.64**	4.89	4.89	.....
3583	7.00	2.50	9.50		3.05	.....	1.95		5.00	5.31	5.31	0.68
.....	*7.50*	*2.50*	*10.00*		*3.00*	.....	*2.00*		*5.00*	*5.00*	*5.00*	.....
2963	.....	.....	.....	.....	15.66	.....	.....	.....	15.66	.....	.....	.....
3164	.....	.....	.....	.....	15.58	.....	.....	.....	15.58	.....	.....	.....
3219	.....	.....	.....	.....	15.83	.....	.....	.....	15.83	.....	.....	.....
3327	.....	.....	.....	.....	15.83	.....	.....	.....	15.83	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3168	5.00	3.40	8.40	*Super, Bn, T*	0.27	0.25	2.50	*Bat G, Bl, Bn*	3.02	4.29	4.29	.....
.....	*6.00*	*2.00*	*8.00*		*1.00*	.....	*2.00*		*3.00*	*4.00*	*4.00*	.....
3183	8.19	1.96	10.15		2.41	0.17	2.57		5.15	5.33	5.33	.....
.....	*7.50*	*2.50*	*10.00*		*2.00*	.....	*3.00*		*5.00*	*5.00*	*5.00*	.....
3378	6.35	5.90	12.25		1.26	.....	2.70		3.96	2.28	2.28	.....
.....	*6.00*	*6.00*	*12.00*		*1.00*	.....	*3.00*		*4.00*	*2.00*	*2.00*	.....
3415	2.91	2.54	5.45		1.71	.....	3.11		4.82	5.05	5.05	1.05
.....	*3.00*	*1.00*	*4.00*		*2.00*	.....	*3.00*		*5.00*	*5.00*	*5.00*	.....
3536	6.20	6.80	13.00		1.12	.....	2.84		3.96	3.13	3.13	.....
.....	.....	.....	*12.00*		*1.00*	.....	*3.00*		*4.00*	*3.00*	*3.00*	.....
3560	7.83	3.62	11.45		2.01	0.15	3.04		5.20	2.25	2.25	0.62
.....	*5.00*	*7.00*	*12.00*		*2.00*	.....	*3.00*		*5.00*	*2.00*	*2.00*	.....
3193	5.45	2.90	8.35	.....	.....	.....	1.67	.....	1.67	1.68	1.68	.....
.....	*4.00*	*4.00*	*8.00*	*Super, T*	.....	.....	*1.50*	*Bl, Bn*	*1.50*	*1.50*	*1.50*	.....
2937	5.65	3.40	9.05	*Super, Bn, T*	2.33	0.27	2.40	*Bat G, Bl, Bn*	5.00	5.12	5.12	.....
.....	*4.00*	*4.00*	*8.00*		*2.00*	.....	*3.00*		*5.00*	*5.00*	*5.00*	.....
2938	5.85	3.20	9.05		2.97	0.16	3.01		6.14	2.31	2.31	.....
.....	*4.00*	*4.00*	*8.00*		*3.00*	.....	*3.00*		*6.00*	*2.00*	*2.00*	.....
2957	5.58	2.82	8.40		2.11	0.18	1.62		3.91	8.45	8.45	.....
.....	*5.00*	*3.00*	*8.00*		*2.00*	.....	*2.00*		*4.00*	*8.00*	*8.00*	.....
2958	6.73	4.02	10.75		1.91	0.26	1.92		4.09	2.68	2.68	.....
3100	7.11	2.84	9.95		1.92	0.24	1.80		3.96	2.79	2.79	.....
.....	*6.00*	*4.00*	*10.00*		*2.00*	.....	*2.00*		*4.00*	*2.00*	*2.00*	.....
2962	5.34	2.36	7.70		.....	.....	1.91		1.91	8.53	8.53	.....
.....	*5.00*	*3.00*	*8.00*		.....	.....	*2.00*		*2.00*	*8.00*	*8.00*	.....
2964	5.46	3.74	9.20		1.58	0.16	2.25		3.99	3.24	3.24	.....
.....	*5.00*	*3.00*	*8.00*		*2.00*	.....	*2.00*		*4.00*	*3.00*	*3.00*	.....
3306	17.18	0.62	17.80	.....	.....	.....	.....	.....	.....	.....	.....	.....
3561	21.86	0.64	22.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
2939	18.72	0.38	19.10	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*18.00*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Agricultural Fertilizer Works— *Continued.*		
2897*	Tankage	C. L. Clock, Redlands	33.72
	Guaranteed		*30.61*
2959*	Tankage	E. A. Moore, Redlands	33.81
	Guaranteed		*31.86*
3099*	Tankage	H. F. Dalrymple, Fullerton	29.37
	Guaranteed		*27.42*
3390*	Tankage	Mrs. A. M. Maddock, Duarte	**31.19**
	Guaranteed		*34.65*
3395*	Tankage	Glendora Citrus Assn., Glendora	25.36
	Guaranteed		*26.70*
3396*	Tankage	John Quick, Glendora	33.87
	Guaranteed		*34.09*
	American Agricultural Chemical Co., Los Angeles, Cal.		
3122	Bradley's California Vegetable	F. E. Dudderar, Covina	$24.00
	Guaranteed		*22.41*
3121	Bradley's Lawn	F. E. Dudderar, Covina	24.90
3151	Bradley's Lawn	E. M. Cope Com'l Co., Redlands	25.85
	Guaranteed		*23.35*
3114	Bradley's Lemon Tree	San Diego Fruit Co., San Diego	25.46
	Guaranteed		*23.34*
2976	Bradley's Nursery Stock	L. V. W. Brown, Riverside	24.33
3120	Bradley's Nursery Stock	F. E. Dudderar, Covina	25.20
3147	Bradley's Nursery Stock	E. C. Robinson, Pomona	25.41
3150	Bradley's Nursery Stock	E. M. Cope Com'l Co., Redlands	25.33
3240	Bradley's Nursery Stock	F. E. Dudderar, Covina	24.85
3329	Bradley's Nursery Stock	R. H. Hille, San Fernando	24.96
3435	Bradley's Nursery Stock	R. S. Thompson, Highland	25.15
3447	Bradley's Nursery Stock	Wm. Bowring, Charter Oak	25.11
3455	Bradley's Nursery Stock	E. R. Kuns, Glendora	25.61
3512	Bradley's Nursery Stock	W. H. Grant, Porterville	25.21
3584	Bradley's Nursery Stock	Tetley, Merriman & Childs, Riverside	24.70
	Guaranteed		*23.35*
3603	Bradley's Special Nursery	The Hammon Orchards, Oroville	22.80
	Guaranteed		*21.57*
2901	Bradley's Orange and Lemon	S. H. Barrett, East Highlands	24.51
2977	Bradley's Orange and Lemon	L. V. W. Brown, Riverside	24.65
3113	Bradley's Orange and Lemon	Pacific Wood & Coal Co., San Diego	24.23
3152	Bradley's Orange and Lemon	E. M. Cope Com'l Co., Redlands	24.01
	Guaranteed		*22.50*
3146	Nitrate of Soda	E. C. Robinson, Pomona	43.12
	Guaranteed		*42.71*

*2897—71% fine.
*2959—73% fine.
*3099—63% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
2897	.....	.....	10.90	*Bn*	.....	.....	6.94	*Bl, Bn*	6.94	.....	.....	.....
.....	.....	.....	*11.50*		.....	.....	*6.00*		*6.00*	.....	.....	.....
2959	.....	.....	11.30		.....	.....	6.71		6.71	.....	.....	.....
.....	.....	.....	*11.60*		.....	.....	*6.15*		*6.15*	.....	.....	.....
3099	.....	.....	17.05		.....	.....	4.64		4.64	.....	.....	.....
.....	.....	.....	*15.00*		.....	.....	*4.50*		*4.50*	.....	.....	.....
3390	.....	.....	10.80		1.76	.....	4.72		**6.48**	.....	.....	.....
.....	.....	.....	*9.50*		.....	.....	*7.00*		*7.00*	.....	.....	.....
3395	.....	.....	13.70		.....	.....	4.15		**4.15**	.....	.....	.....
.....	.....	.....	*11.00*		.....	.....	*5.00*		*5.00*	.....	.....	.....
3396	.....	.....	10.15		.....	.....	6.83		6.83	.....	.....	.....
.....	.....	.....	*9.50*		.....	.....	*7.00*		*7.00*	.....	.....	.....
3122	8.86	0.94	9.80	*Super, Bn*	2.27	0.65	0.75	*Bat G, Bl, Bn*	3.67	3.81	3.81	.....
.....	*8.00*	*1.00*	*9.00*		*1.90*	*0.60*	*0.80*		*3.30*	*4.00*	*4.00*	.....
3124	9.68	1.42	11.10		2.52	0.84	0.91		4.27	1.86	1.86	.....
3151	9.16	1.34	10.50		2.76	0.82	1.14		4.72	1.84	1.84	.....
.....	*9.00*	*1.00*	*10.00*		*2.35*	*0.75*	*1.00*		*4.10*	*1.50*	*1.50*	.....
3114	9.50	1.50	11.00		2.64	0.88	1.01		4.53	1.73	1.73	.....
.....	*9.00*	*1.00*	*10.00*		*2.35*	*0.75*	*1.00*		*4.10*	*1.50*	*1.50*	.....
2976	9.79	1.26	11.05		2.41	0.75	0.93		4.09	1.72	1.72	.....
3120	9.26	1.44	10.70		2.64	0.85	1.02		4.51	1.77	1.77	.....
3147	9.46	1.44	10.90		2.60	0.88	1.02		4.50	1.81	1.81	.....
3150	9.44	1.26	10.70		2.56	0.86	1.08		4.50	1.75	1.75	.....
3240	9.53	0.82	10.35		2.66	0.78	1.01		4.45	1.59	1.59	.....
3329	9.00	1.20	10.20		2.68	0.82	1.05		4.55	1.75	1.75	.....
3435	8.95	1.10	10.05		3.02	0.85	0.90		4.77	1.63	1.63	.....
3447	9.30	1.10	10.40		2.84	0.85	0.91		4.60	1.68	1.68	.....
3455	9.75	0.60	10.35		2.57	0.87	1.10		4.54	1.84	1.84	.....
3512	9.57	0.98	10.55		2.73	0.80	0.97		4.50	1.76	1.76	.....
3584	9.44	1.06	10.50		2.70	0.82	0.93		4.45	1.53	1.53	.....
.....	*9.00*	*1.00*	*10.00*		*2.35*	*0.75*	*1.00*		*4.10*	*1.50*	*1.50*	.....
3603	9.90	1.40	11.30		2.56	0.78	0.78		4.12	.....	.....	.....
.....	*9.00*	*1.00*	*10.00*		*2.25*	*0.75*	*1.00*		*4.00*	.....	.....	.....
2901	8.80	0.95	9.75		2.05	0.75	1.09		3.89	3.34	3.34	.....
2977	8.86	0.74	9.60		2.07	0.70	1.18		3.95	3.24	3.24	.....
3113	8.69	1.06	9.75		2.17	0.77	0.99		3.93	3.15	3.15	.....
3152	8.33	0.82	9.15		2.24	0.69	1.10		4.03	2.97	2.97	.....
.....	*8.00*	*1.00*	*9.00*		*2.20*	*0.70*	*0.80*		*3.70*	*3.00*	*3.00*	.....
3146	.....	.....	.....	.....	15.97	.....	.....	.....	15.97	.....	.....	.....
.....	.....	.....	.....	.....	*15.82*	.....	.....	.....	*15.82*	.....	.....	.....

*3390—Not a Tankage—a mixture of tankage and nitrate of soda.

*3395—66% fine.

*3396—79% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Arlington Heights Fruit Co., Riverside, Cal.		
3104	Nitrate of Soda	Arlington Heights Fruit Co.	40.39
	Guaranteed		*40.50*
3463	Sulphate of Ammonia	Arlington Heights Fruit Co.	58.21
3464	Sulphate of Ammonia	Arlington Heights Fruit Co.	58.21
	Guaranteed		*57.57*
3570	Sulfate of Ammonia	Arlington Heights Fruit Co.	58.18
	Guaranteed		*57.65*
	Armour Fertilizer Works, Los Angeles, Cal.		
3510	Alfalfa Special	J. D. Seal, Porterville	26.32
	Guaranteed		*24.95*
3308	Bat Guano	W. M. Warren, Covina	41.23
	Guaranteed		*38.13*
3309	Bat Guano	L. L. Ratekin, Covina	36.95
	Guaranteed		*35.89*
2904	Blood	W. T. Henderson, Riverside	56.78
2935	Blood	Russel & Arden, Ontario	56.53
3142	Blood	R. T. Murrell, Pomona	58.76
3176	Blood	John Blake, Pasadena	57.08
3351	Blood	A. M. Seeley, Covina	56.99
	Guaranteed		*54.60*
2905	Blood	W. T. Henderson, Riverside	57.24
	Guaranteed		*57.75*
2974*	Blood	Freeman & Fairchild, Redlands	60.81
3220	Blood	W. T. Henderson, Riverside	60.65
3608	Blood	Limoneira Co., Santa Paula	60.40
	Guaranteed		*58.80*
3124	Blood	A. M. Seeley, Covina	56.91
3585	Blood	Tetley, Merriman & Childs, Riverside	50.56
	Guaranteed		*50.40*
3125	Blood	A. M. Seeley, Covina	61.11
	Guaranteed		*55.65*
3462	Blood	James Mills, Riverside	56.24
	Guaranteed		*55.52*
2907	Bone, Blood and Potash	W. T. Henderson, Riverside	30.19
2936	Bone, Blood and Potash	Russel & Arden, Ontario	29.62
2947	Bone, Blood and Potash	Russel & Arden, Ontario	30.33
2969	Bone, Blood and Potash	Freeman & Fairchild, Redlands	31.15
3246	Bone, Blood and Potash	J. C. Boyd, Rialto	28.37
3303	Bone, Blood and Potash	R. E. Fairchild, Redlands	30.66
3314	Bone, Blood and Potash	A. M. Seeley, Covina	30.27
3321	Bone, Blood and Potash	John Cleghorn, Highland	29.73
3324	Bone, Blood and Potash	J. D. Boley, Highland	29.55
3380	Bone, Blood and Potash	P. J. Gilhooly, Los Angeles	30.08
3453	Bone, Blood and Potash	John Cleghorn, Highland	29.77

*2974—Some hoof.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3104	.....	.....	.....	.....	14.96	.....	.....	.....	14.96	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3463	.....	.....	.....	.....	.....	20.79	.....	.....	20.79	.....	.....	.....
3464	.....	.....	.....	.....	.....	20.79	.....	.....	20.79	.....	.....	.....
.....	.....	.....	.....	.....	.....	*20.56*	.....	.....	*20.56*	.....	.....	.....
3570	.....	.....	.....	.....	.....	20.78	.....	.....	20.78	.....	.....	.....
.....	.....	.....	.....	.....	.....	*20.59*	.....	.....	*20.59*	.....	.....	.....
3510	8.85	3.40	12.25	.....	0.67	0.25	1.52	.....	2.44	7.52	7.52	.....
.....	*8.00*	*4.00*	*12.00*	*Super, Bn, G*	*0.50*	.....	*1.50*	*Bl, Bn, G, T*	*2.00*	*8.00*	*8.00*	.....
3308	.....	.....	4.40	.....	2.09	1.10	6.72	.....	9.91	.....	2.55	.....
.....	.....	.....	*3.85*	.....	*1.00*	*2.00*	*6.16*	.....	*9.16*	.....	*2.50*	.....
3309	.....	.....	3.95	.....	1.20	1.09	6.46	.....	8.75	.....	2.06	.....
.....	.....	.....	*3.70*	.....	*1.00*	*2.00*	*5.70*	.....	*8.70*	.....	*2.20*	.....
2904	.....	.....	.....	.....	.....	.....	13.52	.....	13.52	.....	.....	.....
2935	.....	.....	.....	.....	.....	.....	13.46	.....	13.46	.....	.....	.....
3142	.....	.....	.....	.....	.....	.....	13.99	.....	13.99	.....	.....	.....
3176	.....	.....	.....	.....	.....	.....	13.59	.....	13.59	.....	.....	.....
3351	.....	.....	.....	.....	.....	.....	13.57	.....	13.57	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.00*	.....	*13.00*	.....	.....	.....
2905	.....	.....	.....	.....	.....	.....	13.63	.....	13.63	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.75*	.....	*13.75*	.....	.....	.....
2974	.....	.....	.....	.....	.....	.....	14.48	.....	14.48	.....	.....	.....
3220	.....	.....	.....	.....	.....	.....	14.44	.....	14.44	.....	.....	.....
3608	.....	.....	.....	.....	.....	.....	14.38	.....	14.38	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*14.00*	.....	*14.00*	.....	.....	.....
3124	.....	.....	.....	.....	.....	.....	13.55	.....	13.55	.....	.....	.....
3585	.....	.....	.....	.....	.....	.....	12.04	.....	12.04	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*12.00*	.....	*12.00*	.....	.....	.....
3125	.....	.....	.....	.....	.....	.....	14.55	.....	14.55	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.25*	.....	*13.25*	.....	.....	.....
3462	.....	.....	.....	.....	.....	.....	13.39	.....	13.39	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.22*	.....	*13.22*	.....	.....	.....
2907	8.65	2.12	10.77	*Super, Bn, G*	2.05	0.28	1.81	*Bl, Bn, T*	4.14	7.14	7.14	0.80
2936	8.27	2.83	11.10		1.68	0.31	2.01		4.00	6.78	6.78	0.72
2947	9.17	1.68	10.85		1.90	0.36	1.86		4.12	6.93	6.93	0.70
2969	9.25	1.60	10.85		1.99	0.28	1.95		4.22	7.36	7.36	0.75
3246	8.79	1.46	10.25		1.42	0.38	1.85		**3.65**	6.71	6.71	0.70
3303	8.32	1.68	10.00		1.50	0.40	2.23		4.14	6.78	6.78	0.62
3314	8.70	2.00	10.70		1.91	0.32	1.87		4.10	7.25	7.25	0.75
3321	8.06	2.04	10.10		1.29	0.40	2.27		3.96	7.17	7.17	0.75
3324	8.26	2.14	10.40		1.31	0.40	2.19		3.90	7.01	7.01	0.70
3380	8.75	1.50	10.25		1.53	0.28	2.02		3.83	7.74	7.74	0.72
3453	8.33	1.92	10.25		1.66	0.27	1.95		3.88	7.63	7.63	0.75

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton, at Station Prices.
	Armour Fertilizer Works— *Continued.*		
3470	Bone, Blood and Potash	Chas. K. Towt, Lindsay	29.80
3524	Bone, Blood and Potash	Chas. K. Towt, Lindsay	29.45
	Guaranteed		*29.85*
2965	Bone, Blood and Potash	D. P. Stone, Redlands	**27.60**
	Guaranteed		*32.00*
2954*	Bone Meal	Russel & Arden, Ontario	29.65
	Guaranteed		*28.72*
2973*	Bone Meal	Freeman & Fairchild, Redlands	28.95
	Guaranteed		*27.45*
3130*	Bone Meal	W. B. Glidden, Glendora	31.44
	Guaranteed		*28.25*
3144*	Bone Meal	R. T. Murrell, Pomona	28.81
	Guaranteed		*28.78*
3175*	Bone Meal	John Blake, Pasadena	27.22
	Guaranteed		*24.85*
3222*	Bone Meal	W. T. Henderson, Riverside	30.35
	Guaranteed		*28.72*
3244*	Bone Meal	J. C. Boyd, Rialto	29.42
	Guaranteed		*26.85*
3311*	Bone Meal	Chas. H. Low, Riverside	**26.97**
	Guaranteed		*30.06*
3313*	Bone Meal	A. M. Seeley, Covina	28.80
	Guaranteed		*28.66*
3385*	Bone Meal	B. B. Barney, Riverside	28.44
	Guaranteed		*28.78*
3420*	Bone Meal	Azusa Foothills Citrus Assn., Azusa	27.88
	Guaranteed		*24.80*
3418*	Bone Meal	Azusa Foothills Citrus Assn., Azusa	28.08
3419*	Bone Meal	Azusa Foothills Citrus Assn., Azusa	28.08
3421*	Bone Meal	Azusa Foothills Citrus Assn., Azusa	28.32
3422*	Bone Meal	A. M. Seeley, Covina	28.32
	Guaranteed		*24.90*
3145	Double Superphosphate	R. T. Murrell, Pomona	$43.12
	Guaranteed		*44.00*
3302*	Flower and Fern Food	R. E. Fairchilds, Redlands	**27.40**
	Guaranteed		*30.28*
2949	Fruit Special	Russel & Arden, Ontario	22.23
3143	Fruit Special	R. T. Murrell, Pomona	23.10
	Guaranteed		*19.15*
2948	Lawn and Garden	Russel & Arden, Ontario	29.98
3107	Lawn and Garden	H. P. Greene, San Diego	26.30
3174	Lawn and Garden	John Blake, Pasadena	22.41
3509	Lawn and Garden	J. D. Seal, Porterville	23.49
	Guaranteed		*22.45*

*2954—54% fine.
*2973—70% fine.
*3130—60% fine.
3144—62% fine.
*3175—65% fine.
*3222—60% fine.
*3244—59% fine.
*3311—57% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3470	8.40	1.60	10.00	*Super, Bn, G*	1.66	0.25	2.00	*Bl, Bn, T*	3.91	7.58	7.58	0.70
3524	8.59	1.66	10.25		1.20	0.20	2.37		3.77	6.92	6.92	1.00
.....	*8.00*	*2.00*	*10.00*		*1.50*	.....	*2.50*		*4.00*	*7.00*	*7.00*	.....
2965	10.00	1.50	11.50		0.56	0.23	2.50		**3.29**	4.85	**4.85**	0.61
.....	*8.00*	*2.00*	*10.00*		.....	.....	*4.00*		*4.00*	*7.00*	*7.00*	.....
2954	.....	.....	25.00	.....	.....	.....	3.25	.....	3.25	.....	.....	.....
.....	.....	.....	*25.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
2973	.....	.....	26.00	.....	.....	.....	2.80	.....	2.80	.....	.....	.....
.....	.....	.....	*25.50*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....
3130	.....	.....	27.50	.....	.....	.....	3.26	.....	3.26	.....	.....	.....
.....	.....	.....	*27.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....
3144	.....	.....	24.50	.....	.....	.....	3.10	.....	3.10	.....	.....	.....
.....	.....	.....	*25.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
3175	.....	.....	27.00	.....	.....	.....	2.20	.....	**2.20**	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....
3222	.....	.....	25.30	.....	.....	.....	3.38	.....	3.38	.....	.....	.....
.....	.....	.....	*25.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
3244	.....	.....	**23.60**	.....	.....	.....	3.45	.....	3.45	.....	.....	.....
.....	.....	.....	*25.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....
3311	.....	.....	**22.70**	.....	.....	.....	2.98	.....	2.98	.....	.....	.....
.....	.....	.....	*27.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
3313	.....	.....	24.30	.....	.....	.....	3.17	.....	3.17	.....	.....	.....
.....	.....	.....	*25.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
3385	.....	.....	**23.50**	.....	.....	.....	3.19	.....	3.19	.....	.....	.....
.....	.....	.....	*25.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
3420	.....	.....	27.10	.....	.....	.....	2.37	.....	2.37	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....
3418	.....	.....	27.30	.....	.....	.....	2.38	.....	2.38	.....	.....	.....
3419	.....	.....	27.20	.....	.....	.....	2.38	.....	2.38	.....	.....	.....
3421	.....	.....	27.00	.....	.....	.....	2.35	.....	2.35	.....	.....	.....
3422	.....	.....	27.70	.....	.....	.....	2.35	.....	2.35	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....
3145	43.12	2.08	45.20	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*44.00*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3302	**6.06**	5.14	11.20	*Super, Bn, G*	2.32	0.18	2.50	*Bl, Bn, G*	5.00	2.52	2.52	.....
.....	*8.20*	*1.60*	*9.80*		*1.20*	.....	*3.80*		*5.00*	*3.00*	*3.00*	.....
2949	8.75	2.50	11.25		0.78	.....	1.00		1.78	6.37	6.37	.....
3143	8.50	2.40	10.90		0.70	0.20	1.36		2.26	5.75	5.75	0.70
.....	*8.00*	*2.00*	*10.00*		*0.50*	.....	*1.00*		*1.50*	*5.00*	*5.00*	.....
2948	5.45	1.60	7.05		1.77	0.27	2.10		4.14	4.97	4.97	.....
3107	4.08	2.92	7.00		0.82	0.31	3.19		4.32	5.22	5.22	.....
3174	4.46	1.04	5.50		1.42	0.24	2.23		3.89	4.14	4.14	0.62
3509	4.44	0.96	5.40		1.56	0.30	2.34		4.20	4.26	4.26	0.80
.....	*4.00*	*1.00*	*5.00*		*1.50*	.....	*2.50*		*4.00*	*4.00*	*4.00*	.....

*3313—58% fine.
*3385—62% fine.
*3420—63% fine.
*3418—67% fine.
*3419—67% fine.
*3421—67% fine.
*3422—67% fine.
*3302—Total contents of a 2-pound package.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Armour Fertilizer Works— *Continued.*		
3126	Nitrate of Soda	A. M. Seeley, Covina	42.14
2913	Nitrate of Soda	W. T. Henderson, Riverside	40.68
	Guaranteed		*40.50*
3374	Nursery Special	West Highlands Citrus Assn., Highlands	26.16
	Guaranteed		*23.34*
2903	Orange Tree Manure	Thomas Moore, West Riverside	23.50
2968	Orange Tree Manure	Freeman & Fairchild, Redlands	24.20
2978	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	20.92
2979	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.71
2980	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	24.17
2981	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.66
2982	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.28
2983	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.55
2985	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	21.37
2986	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	24.44
2989	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	21.85
2990	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.08
2991	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.65
2994	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	24.63
2995	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.99
2996	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.12
2997	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	21.94
2998	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.95
3004	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.35
3005	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.11
3006	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	21.34
3007	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	21.19
3009	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.51
3010	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.24
3011	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.63
3012	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.45
3013	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.93
3015	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.53
3034	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.20
3035	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.62
3036	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.67
3038	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.71
3039	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.16
3040	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	22.49
3041	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.09
3048	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	24.59
3049	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.50
3050	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.59
3051	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.95
3052	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.04
3053	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.63
3058	Orange Tree Manure	Arlington Heights Fruit Co., Riverside	23.49
3212	Orange Tree Manure	Chas. T. Paine, Redlands	23.12
3305	Orange Tree Manure	R. E. Fairchild, Redlands	22.92
3472	Orange Tree Manure	Gifford & Morgan, Lindsay	22.12
3508	Orange Tree Manure	J. D. Seal, Porterville	22.91
	Guaranteed		*22.85*

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3126	.....	.....	.....	.....	15.61	.....	.....	.....	15.61	.....	.....	.....
2913	.....	.....	.....	.....	15.07	.....	.....	.....	15.07	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3374	10.14	0.46	10.60		2.59	0.22	1.59		4.40	1.87	1.87	.....
.....	*9.00*	*1.00*	*10.00*		*2.35*	*0.75*	*1.00*		*4.10*	*1.50*	*1.50*	.....
2903	8.46	2.24	10.70		1.16	0.48	1.31		2.95	4.43	4.43	.....
2968	8.87	2.08	10.95		1.42	0.29	1.38		3.09	4.33	4.33	.....
2978	8.14	1.86	10.00		1.25	0.18	1.10		**2.53**	3.77	3.77	.....
2979	8.64	1.76	10.40		1.29	0.26	1.40		2.95	4.57	4.57	.....
2980	7.70	1.90	9.60		1.53	0.24	1.43		3.20	5.19	5.19	.....
2981	8.54	1.46	10.00		1.48	0.25	1.32		3.05	4.56	4.56	.....
2982	7.82	1.78	9.60		1.39	0.20	1.23		2.82	4.52	4.52	.....
2983	7.99	1.76	9.75		1.42	0.23	1.23		2.88	4.47	4.47	.....
2985	7.24	1.76	9.00		1.22	0.25	1.30		2.77	4.24	4.24	.....
2986	7.93	1.82	9.75		1.29	0.23	1.29		2.81	4.50	4.50	.....
2989	9.94	1.06	11.00		0.94	0.20	1.15		**2.29**	3.79	3.79	.....
2990	8.60	1.40	10.00		1.43	0.25	1.22		2.90	4.48	4.48	.....
2991	9.70	1.20	10.90		1.19	0.25	1.32		2.76	4.28	4.28	.....
2994	10.38	1.72	12.10		1.63	0.23	1.35		3.21	3.12	**3.12**	.....
2995	8.90	1.40	10.30		1.16	0.25	1.27		**2.68**	4.62	4.62	.....
2996	8.55	1.20	9.75		1.40	0.21	1.16		2.77	4.06	4.06	.....
2997	7.99	1.56	9.55		1.24	0.20	1.12		**2.56**	4.94	4.94	.....
2998	8.99	1.36	10.35		1.23	0.27	1.34		2.84	3.98	3.98	.....
3004	9.14	1.86	11.00		1.23	0.25	1.36		2.84	4.01	4.01	.....
3005	8.15	1.60	9.75		1.54	0.21	1.29		3.04	4.43	4.43	.....
3006	7.60	1.70	9.30		1.44	0.21	1.11		2.76	4.15	4.15	.....
3007	8.25	1.50	9.75		1.03	0.20	1.16		**2.39**	4.36	4.36	.....
3009	8.03	1.62	9.65		1.36	0.16	1.31		2.83	4.47	4.47	.....
3010	8.09	1.66	9.75		1.48	0.16	1.33		2.97	4.73	4.73	.....
3011	8.08	1.42	9.50		1.54	0.16	1.32		3.02	5.10	5.10	.....
3012	8.12	1.28	9.40		1.38	0.20	1.21		2.79	4.70	4.70	.....
3013	8.69	1.36	10.05		1.33	0.20	1.33		2.86	4.23	4.23	.....
3015	8.90	1.60	10.50		1.14	0.20	1.36		**2.70**	3.92	3.92	.....
3034	7.72	1.78	9.50		1.21	0.22	1.55		2.98	3.69	3.69	.....
3035	8.60	1.70	10.30		1.45	0.17	1.28		**2.61**	3.84	3.84	.....
3036	8.55	1.60	10.15		1.29	0.19	1.28		2.76	4.35	4.35	.....
3038	8.40	1.60	10.00		1.40	0.20	1.41		3.01	4.69	4.69	.....
3039	8.50	1.40	9.90		1.38	0.19	1.34		2.91	4.48	4.48	.....
3040	7.99	1.66	9.65		1.31	0.23	1.54		3.08	3.51	3.51	.....
3041	8.96	1.44	10.40		1.32	0.18	1.40		2.90	3.90	3.90	.....
3048	8.58	1.82	10.40		1.20	0.22	1.74		3.16	4.46	4.46	0.80
3049	8.44	1.66	10.10		1.17	0.20	1.46		2.83	4.85	4.85	0.60
3050	9.15	1.60	10.75		1.20	0.20	1.36		2.76	4.56	4.56	0.60
3051	7.79	1.46	9.25		1.52	0.20	1.44		3.16	5.16	5.16	0.65
3052	8.64	1.66	10.30		1.31	0.20	1.40		2.91	4.04	4.04	0.65
3053	8.48	1.52	9.90		1.38	0.20	1.47		3.05	4.38	4.38	0.75
3058	8.65	1.50	10.15		1.20	0.20	1.50		2.90	4.45	4.45	0.60
3212	8.55	1.70	10.25		1.24	0.20	1.47		2.91	4.10	4.10	.....
3305	8.15	1.80	9.95		1.21	0.23	1.56		3.00	3.90	3.90	.....
3472	8.25	1.60	9.85		1.34	0.20	1.22		2.76	4.17	4.17	.....
3508	8.16	2.14	10.30		1.40	0.14	1.36		2.90	4.28	4.28	.....
.....	*8.00*	*2.00*	*10.00*	*Super, Bn, G*	*1.50*	.....	*1.50*	*Bl, Bn, G, T*	*3.00*	*4.00*	*4.00*	

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Armour Fertilizer Works— *Continued.*		
2972	Special	Freeman & Fairchild, Redlands	34.65
	Guaranteed		*32.00*
3213	Special	C. R. Paine, Redlands	31.76
	Guaranteed		*30.85*
3248	Special	J. C. Boyd, Rialto	33.09
	Guaranteed		*39.40*
3399	Special	D. B. Lee, Ontario	37.48
3400	Special	D. B. Lee, Ontario	36.74
	Guaranteed		*36.40*
3515	Special	Merryman Ft., Lnd. & Lbr. Co., Exeter	27.13
	Guaranteed		*26.95*
2906	Special *5–8–2*	W. T. Henderson, Riverside	24.39
2934	Special *5–8–2*	Russel & Arden, Ontario	24.92
2971	Special *5–8–2*	Freeman & Fairchild, Redlands	25.61
3123	Special *5–8–2*	A. M. Seeley, Covina	24.58
3262	Special *5–8–2*	J. C. Boyd, Rialto	24.69
3304	Special *5–8–2*	R. E. Fairchild, Redlands	25.56
3322	Special *5–8–2*	Geo. W. Prescott, Highland	26.05
3471	Special *5–8–2*	Gifford & Morgan, Lindsay	25.61
3507	Special *5–8–2*	I. J. Booth, Porterville	24.43
3513	Special *5–8–2*	J. D. Seal, Porterville	24.08
3523*	Special *5–8–2*	H. C. Ray, Visalia	23.39
	Guaranteed		*24.85*
3429	Special *10–5–2*	C. C. Cady, Covina	40.50
	Guaranteed		*37.80*
3221	Sulfate of Potash	W. T. Henderson, Riverside	49.36
	Guaranteed		*48.00*
2902*	Tankage	W. T. Henderson, Riverside	29.76
	Guaranteed		*29.10*
2912*	Tankage	W. T. Henderson, Riverside	34.40
	Guaranteed		*34.51*
2970*	Tankage	Freeman & Fairchild, Redlands	34.78
	Guaranteed		*33.95*
2975*	Tankage	Freeman & Fairchild, Redlands	45.48
	Guaranteed		*46.20*
3245*	Tankage	J. C. Boyd, Rialto	31.98
	Guaranteed		*30.96*
3247*	Tankage	J. C. Boyd, Rialto	**44.73**
	Guaranteed		*51.25*
3254*	Tankage	J. S. Benner, San Bernardino	35.49
	Guaranteed		*34.65*
3323*	Tankage	Arthur L. Brooks, Highland	29.16
	Guaranteed		*28.94*
3326*	Tankage	A. M. Seeley, Covina	30.55
	Guaranteed		*28.31*
3428*	Tankage	B. L. King, Covina	34.62
	Guaranteed		*35.39*
3461*	Tankage	Arlington Heights Fruit Co., Riverside	36.38
	Guaranteed		*35.55*

*3523—Tagged Special *10—5—2* in error. *2902—73% fine. *2912—79% fine. *2970—93% fine. *2975—"Stick."

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
2972	.....	.....	20.20	.....	.....	.....	2.70	.....	2.70	9.71	9.71	
.....	.....	.....	*20.00*	*Bn*	.....	.....	*2.00*	*Bn*	*2.00*	*10.00*	*10.00*	
3213	8.40	1.80	10.20	.....	1.53	0.45	3.17	.....	5.15	4.57	4.57	0.9
.....	*8.00*	*2.00*	*10.00*	*Super Bn, G*	*1.50*	.....	*3.50*	*Bl, Bn, G, T*	*5.00*	*4.00*	*4.00*	
3248	.....	.....	12.15	.....	3.02	1.69	2.17	.....	6.88	3.03	3.03	0.7
.....	.....	.....	*12.00*	*Bn, G*	.....	.....	*7.00*	*Bn, G*	*7.00*	*3.00*	*3.00*	
3399	.....	.....	12.40	.....	.....	.....	6.05	.....	6.05	4.60	4.60	
3400	.....	.....	11.65	.....	.....	.....	6.01	.....	6.01	4.55	4.55	
.....	.....	.....	*12.00*	*Bn*	.....	.....	*6.00*	*Bl, Bn, T*	*6.00*	*4.00*	*4.00*	
3515	8.54	3.16	11.70		0.61	0.22	1.35		2.18	9.66	9.66	0.7
.....	*8.00*	*4.00*	*12.00*		*0.50*	.....	*1.50*		*2.00*	*10.00*	*10.00*	
2906	6.94	2.96	9.90		1.93	0.28	1.91		4.12	2.64	2.64	0.8
2934	8.75	1.80	10.55		1.47	0.30	2.07		3.84	2.36	2.36	
2971	8.96	1.94	10.90		1.83	0.25	2.02		4.10	2.16	2.16	
3123	7.71	2.04	9.75		2.15	0.26	1.74		4.15	2.56	2.56	0.6
3262	8.82	1.88	10.70		1.37	0.32	2.10		3.79	2.12	2.12	
3304	8.25	2.00	10.25	*Super, Bn, G*	1.50	0.37	2.30	*Bl, Bn, G, T*	4.17	2.22	2.22	
3322	8.35	2.20	10.55		1.45	0.40	2.18		4.03	2.27	2.27	0.7
3471	9.00	1.80	10.80		1.37	0.33	2.25		3.95	2.27	2.27	
3507	8.86	1.64	10.50		1.54	0.24	1.93		**3.71**	2.36	2.36	
3513	8.55	1.40	9.95		1.63	0.30	1.85		3.78	2.33	2.33	
3523	.....	.....	10.05		1.61	0.25	2.12		3.98	2.30	2.30	
.....	*8.00*	*2.00*	*10.00*		*1.50*	.....	*2.50*		*4.00*	*2.00*	*2.00*	
3429	.....	.....	5.50	.....	2.08	0.75	6.52		**9.35**	2.86	2.86	
.....	.....	.....	*5.00*	*Bn, G*	*5.00*	*1.00*	*4.00*	*Bl, Bn, G, T*	*10.00*	*2.00*	*2.00*	
3221	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.36	49.36	0.96
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*48.00*	*48.00*	
2902	.....	.....	14.00		.....	.....	5.17		5.17	.....	.....	
.....	.....	.....	*14.00*		.....	.....	*5.00*		*5.00*	.....	.....	
2912	.....	.....	6.15		.....	.....	7.68		7.68	.....	.....	
.....	.....	.....	*5.90*		.....	.....	*7.75*		*7.75*	.....	.....	
2970	.....	.....	5.65		.....	.....	7.63		7.63	.....	.....	
.....	.....	.....	*5.80*		.....	.....	*7.40*		*7.40*	.....	.....	
2975	.....	.....	.....		.....	.....	10.83		10.83	.....	.....	
.....	.....	.....	.....		.....	.....	*11.00*		*11.00*	.....	.....	
3245	.....	.....	19.60		.....	.....	4.91		4.91	.....	.....	
.....	.....	.....	*19.00*		.....	.....	*4.75*		*4.75*	.....	.....	
3247	.....	.....	.....		.....	.....	10.91		**10.91**	.....	.....	
.....	.....	.....	.....	*Bn*	.....	.....	*12.50*	*Bl, Bn*	*12.50*	.....	.....	
3254	.....	.....	11.85		.....	.....	7.16		7.16	.....	.....	
.....	.....	.....	*11.50*		.....	.....	*7.00*		*7.00*	.....	.....	
3323	.....	.....	**10.35**		.....	.....	5.80		5.80	.....	.....	
.....	.....	.....	*13.00*		.....	.....	*5.25*		*5.25*	.....	.....	
3326	.....	.....	10.85		.....	.....	6.01		6.01	.....	.....	
.....	.....	.....	*11.50*		.....	.....	*5.25*		*5.25*	.....	.....	
3428	.....	.....	8.75		.....	.....	7.16		**7.16**	.....	.....	
.....	.....	.....	*6.50*		.....	.....	*7.75*		*7.75*	.....	.....	
3461	.....	.....	8.15		.....	.....	7.67		7.67	.....	.....	
.....	.....	.....	*6.50*		.....	.....	*7.75*		*7.75*	.....	.....	

*3245—58% fine. *3254—66% fine. *3326—74% fine. *3461—89% fine.
*3247—"Stick." *3323—65% fine. *3428—86% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Armour Fertilizer Works— *Continued.*		
3571*	Tankage	Arlington Heights Fruit Co., Riverside	36.64
	Guaranteed		*34.27*
3594*	Tankage	Arlington Heights Fruit Co., Riverside	37.66
	Guaranteed		*36.75*
3595*	Tankage	Arlington Heights Fruit Co., Riverside	35.59
	Guaranteed		*35.52*
3607*	Tankage	Arlington Heights Fruit Co., Riverside	36.69
	Guaranteed		*36.45*
	Balfour, Guthrie & Co., San Francisco, Cal.		
3593	Double Superphosphate	Arlington Heights Fruit Co., Riverside	45.68
	Guaranteed		*45.63*
3080	Nitrate of Soda	Balfour, Guthrie & Co., Los Angeles	39.96
	Guaranteed		*40.50*
3127*	Thomas Phosphate Powder	W. C. McCully, Corona	13.51
3128*	Thomas Phosphate Powder	W. C. McCully, Corona	13.65
	Guaranteed		*13.71*
3590*	Thomas Phosphate Powder	Arlington Heights Fruit Co., Riverside	14.00
3591*	Thomas Phosphate Powder	Arlington Heights Fruit Co., Riverside	14.07
3592*	Thomas Phosphate Powder	Arlington Heights Fruit Co., Riverside	14.21
	Guaranteed		*14.15*
	Braun Chemical Co., Los Angeles, Cal.		
2926	Bat Guano	Bollinger & Crane, Riverside	**48.85**
	Guaranteed		*60.71*
2925*	Bone Flour	Bollinger & Crane, Riverside	26.18
	Guaranteed		*25.06*
3172*	Bone Flour	V. Peyton, Los Angeles	26.82
	Guaranteed		*24.23*
3181*	Bone Flour	R. L. Willits, Corona	27.05
	Guaranteed		*24.55*
3568*	Bone Flour	Whittier Citrus Assn., Whittier	.....
	Sold on Station Analysis.		
3054*	Bone Meal	Southern Calif. Fert. Co., Ontario	29.18
	Guaranteed		*27.99*
3030	Nitrate of Lime	Southern Calif. Fert. Co., Ontario	**33.96**
	Guaranteed		*35.10*
3110	Nitrate of Soda	Chula Vista L. G. Assn., Chula Vista	41.90
	Guaranteed		*42.25*
3160	Nitrate of Soda	Santiago O. G. Assn., Orange	41.01
3364	Nitrate of Soda	Azusa Citrus Assn., Azusa	42.06
	Guaranteed		*40.50*
2988	Sulfate of Potash	Southern Calif. Fert. Co., Ontario	48.72
3095	Sulfate of Potash	S. W. McColloch, Fullerton	48.83

*3571—76% fine.
*3594—80% fine.
*3595—63% fine.
*3607—75% fine.
*3127—77% fine.
*3128—75% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3571	.....	.....	12.55	*Bn*	.....	.....	7.18	*Bl, Bn*	**7.18**	.....	.....	.....
.....	.....	.....	*6.00*		.....	.....	*7.75*		*7.75*	.....	.....	.....
3594	.....	.....	13.65		.....	.....	7.17		**7.17**	.....	.....	.....
.....	.....	.....	*9.39*		.....	.....	*7.70*		*7.70*	.....	.....	.....
3595	.....	.....	10.60		.....	.....	7.48		7.48	.....	.....	.....
.....	.....	.....	*9.39*		.....	.....	*7.70*		*7.70*	.....	.....	.....
3607	.....	.....	15.50		.....	.....	6.66		**6.66**	.....	.....	.....
.....	.....	.....	*9.39*		.....	.....	*7.70*		*7.70*	.....	.....	.....
3593	45.68	1.02	46.70	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*45.63*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3080	.....	.....	.....	.....	14.80	.....	.....	.....	14.80	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3127	.....	.....	19.30	.....	.....	.....	.....	.....	.....	.....	.....	.....
3128	.....	.....	19.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	*19.59*	.....	.....	.....	.....	.....	.....	.....	.....	.....
3590	.....	.....	20.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
3591	.....	.....	20.10	.....	.....	.....	.....	.....	.....	.....	.....	.....
3592	.....	.....	20.30	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	*20.22*	.....	.....	.....	.....	.....	.....	.....	.....	.....
2926	.....	.....	3.50	.....	4.18	1.04	7.70	.....	**12.92**	.....	1.40	.....
.....	.....	.....	*2.50*	.....	.....	.....	*14.49*	.....	*14.49*	.....	*1.00*	.....
2925	.....	.....	33.00	.....	.....	.....	0.76	.....	0.76	.....	.....	.....
.....	.....	.....	*30.00*	.....	.....	.....	*1.00*	.....	*1.00*	.....	.....	.....
3172	.....	.....	31.20	.....	.....	.....	1.22	.....	1.22	.....	.....	.....
.....	.....	.....	*27.45*	.....	.....	.....	*1.23*	.....	*1.23*	.....	.....	.....
3181	.....	.....	31.00	.....	.....	.....	1.33	.....	1.33	.....	.....	.....
.....	.....	.....	*28.00*	.....	.....	.....	*1.23*	.....	*1.23*	.....	.....	.....
3568	.....	.....	31.00	.....	.....	.....	1.25	.....	1.25	.....	.....	.....
3054	.....	.....	21.50	.....	.....	.....	4.06	.....	4.06	.....	.....	.....
.....	.....	.....	*20.10*	.....	.....	.....	*4.00*	.....	*4.00*	.....	.....	.....
3030	.....	.....	.....	.....	12.58	.....	.....	.....	**12.58**	.....	.....	.....
.....	.....	.....	.....	.....	*13.00*	.....	.....	.....	*13.00*	.....	.....	.....
3110	.....	.....	.....	.....	15.52	.....	.....	.....	15.52	.....	.....	.....
.....	.....	.....	.....	.....	*15.65*	.....	.....	.....	*15.65*	.....	.....	.....
3160	.....	.....	.....	.....	15.19	.....	.....	.....	15.19	.....	.....	.....
3364	.....	.....	.....	.....	15.58	.....	.....	.....	15.58	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
2988	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.72	48.72	2.06
3095	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.88	48.88	1.02

*3590—77% fine.
*3591—80% fine.
*3592—78% fine.

*2925—96% fine.
*3172—97% fine.
*3181—92% fine.

*3568—78% fine.
*3054—31% fine. Some hoof.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Braun Chemical Co.— *Continued.*		
3439	Sulfate of Potash	S. W. McColloch, Fullerton	50.24
	Guaranteed		*45.00*
3129	Sulfate of Potash	Bloomington Fruit Assn., Bloomington	51.80
	Guaranteed		*51.10*
3119	Superphosphate	Horace Evans, Monrovia	22.18
	Guaranteed		*20.00*
3149	Superphosphate	H. H. Beckwith, Glendora	20.70
3157	Superphosphate	Sydmer Ross, Fullerton	20.84
3159	Superphosphate	Santiago O. G. Assn., Orange	20.80
3358	Superphosphate	Santiago O. G. Assn., Orange	21.48
3494	Superphosphate	H. S. Thornberry, Lordsburg	21.94
	Guaranteed		*20.80*
2924*	Tankage	E. A. Zumbro, Riverside	.....
3008*	Tankage	J. E. Cutter, Riverside	.....
3116*	Tankage	Bloomington Fruit Assn., Bloomington	.....
3117*	Tankage	Bloomington Fruit Assn., Bloomington	.....
3118*	Tankage	Bloomington Fruit Assn., Bloomington	.....
	Sold on Station Analysis.		
3188*	Tankage	M. M. Seabolt, Bloomington	35.36
	Guaranteed		*36.65*
3339*	Tankage	P. J. Bollinger, Riverside	35.77
	Guaranteed		*35.36*
	California Fertilizer Works, San Francisco, Cal.		
3542	"B"	Silva-Bergtholt Co., Newcastle	23.30
	Guaranteed		*26.65*
2931	Blood	Hanson & Seares, Upland	**46.45**
2956	Blood	J. W. McCrie, Riverside	**44.60**
	Guaranteed		*48.34*
3543	"C"	Silva-Bergtholt Co., Newcastle	**24.70**
	Guaranteed		*27.00*
3481	Fruit and Vine	A. C. Dungan, Exeter	24.21
3487	Fruit and Vine	J. R. Balkwell, Parlier	23.02
	Guaranteed		*23.70*
3488	Fruit, Orange and Vine	Kings River Orchard Co., Fresno	24.01
3491	Fruit, Orange and Vine	N. W. Moody, Sanger	22.97
	Guaranteed		*23.42*
2932	High Grade Bone and Blood	Hanson & Seares, Upland	33.00
	Guaranteed		*30.73*
3133	High Grade Bone and Blood	A. T. Botts, Palermo	32.13
	Guaranteed		*31.71*
3496	High Grade Bone and Blood	H. Postlethwaite, San Jose	31.77
	Guaranteed		*31.80*
3489	High Grade Bone and Blood Supr.	Becker Bros., Fresno	30.42
	Guaranteed		*29.60*

*2924—70% fine.
*3008—70% fine.
*3116—64% fine.
*3117—67% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3439	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.24	50.24	1.70
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*45.00*	*45.00*	.....
3129	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.80	51.80	1.54
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*51.10*	*51.10*	.....
3119	22.18	0.32	22.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*20.00*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3149	20.70	0.30	21.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
3157	20.84	0.26	21.10	.....	.....	.....	.....	.....	.....	.....	.....	.....
3159	20.80	0.20	21.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
3358	21.48	0.32	21.80	.....	.....	.....	.....	.....	.....	.....	.....	.....
3494	21.94	0.26	22.20	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*20.80*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2924	.....	.....	8.95	*Bn*	.....	.....	5.89	*Bl, Bn*	5.89	.....	.....	.....
3008	.....	.....	8.90		.....	.....	5.58		5.58	.....	.....	.....
3116	.....	.....	7.75		.....	.....	6.06		6.06	.....	.....	.....
3117	.....	.....	8.05		.....	.....	6.26		6.26	.....	.....	.....
3118	.....	.....	8.50		.....	.....	5.86		5.86	.....	.....	.....
3188	.....	.....	**10.50**		.....	.....	7.45		7.45	.....	.....	.....
.....	.....	.....	*13.04*		.....	.....	*7.32*		*7.32*	.....	.....	.....
3339	.....	.....	13.00		.....	.....	7.17		**7.17**	.....	.....	.....
.....	.....	.....	*8.00*		.....	.....	*8.00*		*8.00*	.....	.....	.....
3542	.....	.....	7.15	.....	1.19	0.45	2.63	.....	**4.27**	3.31	3.31	0.60
.....	.....	.....	*7.00*	*Bn Supr*	*1.00*	.....	*4.00*	*Bl, Bn*	*5.00*	*3.00*	*3.00*	.....
2931	.....	.....	.....	.....	.....	.....	11.06	.....	**11.06**	.....	.....	.....
2956	.....	.....	.....	.....	.....	.....	10.62	.....	**10.62**	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*11.51*	.....	*11.51*	.....	.....	.....
3543	.....	.....	**8.50**	.....	.....	.....	2.31	.....	2.31	9.51	9.51	0.90
.....	.....	.....	*10.00*	*Bn Supr*	.....	.....	*2.50*	*Bl, Bn*	*2.50*	*10.00*	*10.00*	.....
3481	6.06	3.24	9.30	*Super*	0.86	0.15	1.80	*Bl, Bn*	2.81	6.91	6.91	0.70
3487	5.37	3.88	9.25		0.66	0.16	1.80		2.62	6.67	6.67	0.75
.....	*6.00*	*3.00*	*9.00*		*0.50*	.....	*2.00*		*2.50*	*7.15*	*7.15*	.....
3488	5.73	3.52	9.25		0.83	0.15	1.90		2.88	6.61	6.61	0.75
3491	5.46	3.64	9.10		0.45	0.20	1.93		2.58	6.55	6.55	0.75
.....	*6.00*	*3.50*	*9.50*		*0.75*	.....	*2.00*		*2.75*	*6.00*	*6.00*	.....
2932	.....	.....	23.00	*Bn*	.....	.....	4.52	*Bl, Bn*	4.52	.....	.....	.....
.....	.....	.....	*22.00*		.....	.....	*4.10*		*4.10*	.....	.....	.....
3133	.....	.....	23.10		.....	.....	4.01		4.01	.....	.....	.....
.....	.....	.....	*22.00*		.....	.....	*4.10*		*4.10*	.....	.....	.....
3496	.....	.....	23.50		.....	.....	3.83		**3.83**	.....	.....	.....
.....	.....	.....	*22.00*		.....	.....	*4.10*		*4.10*	.....	.....	.....
3489	13.33	4.82	18.15	.....	.....	.....	3.79	.....	3.79	.....	.....	.....
.....	*12.00*	*5.00*	*17.00*	*Bn Supr*	.....	.....	*3.90*	*Bl, Bn*	*3.90*	.....	.....	.....

*3118—66% fine. *3339—57% fine. *3133—86% fine.
*3188—63% fine. *2932—61% fine. *3496—89% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	California Fertilizer Works— *Continued.*		
3490	Nitrate of Soda	J. H. Hudson, Fresno	42.36
	Guaranteed		*40.50*
3197	Orange Tree B	G. W. Wyllie, Dinuba	23.72
	Guaranteed		*22.78*
3349	Peach	G. W. Hume Co., Los Gatos	25.02
	Guaranteed		*23.90*
3514	Special	H. Postlethwaite, San Jose	28.18
	Guaranteed		*28.10*
3519	Special	A. T. Botts, Palermo	28.14
	Guaranteed		*25.80*
3575*	Special	J. E. Coombs, Pasadena	29.17
	Guaranteed		*29.50*
3604*	Special	The Hammon Orchards, Oroville	26.21
	Guaranteed		*28.40*
3061	Special A	Redlands Fertilizer Assn., Redlands	25.41
	Guaranteed		*25.10*
3483*	Special No. 2	A. C. Dungan, Exeter	28.69
	Guaranteed		*36.55*
2955	Special Nursery Stock	J. W. McCrie, Riverside	23.88
3190	Special Nursery Stock	A. T. Botts, Palermo	26.22
3482	Special Nursery Stock	A. C. Dungan, Exeter	25.16
3518	Special Nursery Stock	A. T. Botts, Palermo	23.92
	Guaranteed		*24.90*
3525	Special Nursery Stock	R. H. Shoemaker, Lindsay	25.40
	Guaranteed		*26.25*
2929	Special Orange and Lemon	Hanson & Seares, Upland	24.06
3516	Special Orange and Lemon	J. Weil, San Jose	24.09
	Guaranteed		*23.95*
3492	Special Orange Tree	Mrs. M. Vian, Sanger	24.45
	Guaranteed		*24.18*
3511	Special Orange Tree	Robert Baird, Porterville	24.80
3578	Special Orange Tree	Robert Baird, Porterville	24.29
	Guaranteed		*25.55*
3192	Sulfate of Ammonia	A. T. Botts, Palermo	57.09
	Guaranteed		*56.00*
3191	Superphosphate	A. T. Botts, Palermo	19.10
	Guaranteed		*18.00*
	California Ranch Supply and Fertilizer Exchange, Upland.		
2930	Nitrate, Super and Potash	R. T. Nelson, Upland	23.19
	Guaranteed		*22.35*
3347	Sulfate of Potash	R. T. Nelson, Upland	49.12
	Guaranteed		*49.00*

*3575—Nitrogen not properly guaranteed.

*3604—Discrepancy in valuation due to inadequacy of guaranty.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3490	.....	.....	.....	.....	15.69	.....	.....	.....	15.69	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3197	6.85	2.00	8.85		0.11	0.82	0.94		1.87	9.72	9.72	0.85
.....	*6.00*	*3.00*	*9.00*		.....	*0.83*	*0.82*		*1.65*	*10.00*	*10.00*	.....
3349	6.08	3.32	9.40		0.09	0.36	2.97		3.42	4.48	4.48	0.67
.....	*6.50*	*3.50*	*10.00*		.....	.....	*3.00*		*3.00*	*4.00*	*4.00*	.....
3514	10.30	1.10	11.40		0.20	2.15	0.45		2.80	9.08	**9.08**	0.62
.....	*9.00*	*1.00*	*10.00*		.....	*2.75*	*0.25*		*3.00*	*10.00*	*10.00*	.....
3519	11.41	2.84	14.25		2.30	0.47	1.48		4.25	2.14	2.14	.....
.....	*8.00*	*6.00*	*14.00*		*2.00*	.....	*2.00*		*4.00*	*2.00*	*2.00*	.....
3575	6.85	0.40	7.25	.....	4.64	0.85	0.20	.....	**5.69**	6.45	6.45	0.70
.....	*6.00*	*0.50*	*6.50*	*Super*	*6.00*		.....	.....	*6.00*	*6.50*	*6.50*	.....
3604	10.30	4.50	14.80	.....	3.17	0.67	0.92	.....	4.76	.....	.....	.....
.....	*9.00*	*5.00*	*14.00*	*Bn Supr*	*2.00*	.....	*3.00*	*Bl, Bn*	*5.00*	.....	.....	.....
3061	.....	.....	11.60	.....	0.83	0.60	2.75	.....	4.18	2.37	2.37	0.67
.....	.....	.....	*12.00*	*Bn*	*1.00*	.....	*3.00*	*Bl, Bn*	*4.00*	*2.00*	*2.00*	.....
3483	6.25	0.50	6.75	.....	5.73	0.69	0.20	.....	**6.62**	4.04	4.04	.....
.....	.....	.....	*6.50*	.....	.....	.....	*7.00*	.....	*7.00*	*4.00*	*4.00*	.....
2955	7.11	2.44	9.55		1.45	0.63	1.95		4.03	2.32	2.32	.....
3190	8.39	2.76	11.15		1.08	0.76	2.40		4.24	2.08	2.08	.....
3482	7.31	2.74	10.05		1.30	0.45	2.40		4.15	2.38	2.38	.....
3518	7.35	2.50	9.85		1.43	0.25	2.17		3.85	2.33	2.33	.....
.....	*7.00*	*3.00*	*10.00*		*1.00*	.....	*3.00*		*4.00*	*2.00*	*2.00*	.....
3525	7.46	3.04	10.50		1.54	0.53	2.26		4.33	2.04	2.04	0.65
.....	*7.00*	*3.00*	*10.00*		*1.50*	.....	*3.00*		*4.50*	*2.00*	*2.00*	.....
2929	7.56	2.14	9.70		0.90	0.36	1.84		3.10	4.87	4.87	0.78
3516	7.15	3.00	10.15		0.87	0.25	1.76		2.88	5.65	5.65	0.75
.....	*6.00*	*4.00*	*10.00*		*0.50*	.....	*2.50*		*3.00*	*5.00*	*5.00*	.....
3492	7.16	3.24	10.40		0.69	0.18	1.61		2.48	7.29	7.29	0.75
.....	*6.00*	*3.50*	*9.50*		*0.25*	.....	*2.25*		*2.50*	*7.10*	*7.10*	.....
3511	7.50	2.60	10.10		1.10	0.20	1.50		2.80	6.73	**6.73**	0.65
3578	7.25	3.00	10.25		0.99	0.15	1.50		2.64	6.75	**6.75**	0.62
.....	*7.00*	*3.00*	*10.00*		*0.50*	.....	*2.00*		*2.50*	*8.00*	*8.00*	.....
3192	.....	.....	.....	.....	.....	20.39	.....	.....	20.39	.....	.....	.....
.....	.....	.....	.....	.....	.....	*20.00*	.....	.....	*20.00*	.....	.....	.....
3191	19.10	0.30	19.40	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*18.00*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2930	10.35	0.30	10.65	.....	2.97	.....	.....	.....	2.97	4.71	4.71	.....
.....	*9.35*	.....	.....	.....	*3.15*	.....	.....	.....	*3.15*	*4.50*	*4.50*	.....
3347	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.12	49.12	2.44
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*49.00*	*49.00*	.....

*3483—Derivations not guaranteed. Discrepancy in valuation due to inadequacy in guaranty.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Carlsbad Guano and Fertilizer Co., Redlands, Cal.		
2900*	Bat Guano	T. O. Johnson, Redlands	22.76
	Guaranteed		*21.60*
3137*	Bat Guano	Glendora Citrus Assn., Glendora	24.11
	Guaranteed		*28.85*
3288*	Bat Guano	D. A. Crawford, Rialto	22.68
	Guaranteed		*27.50*
3368	Bat Guano	A. L. Wright, Jr., Rialto	18.97
	Guaranteed		*20.40*
3369*	Bat Guano	Jonas & Wright, Rialto	19.85
	Guaranteed		*25.00*
3373	Bat Guano and Tankage	Peter Arth, Jr., Redlands	24.11
	Guaranteed		*25.80*
3073	Blood	Factory, Redlands	58.67
	Guaranteed		*59.22*
3135*	Bone Meal	L. F. Churchill, Redlands	30.24
	Guaranteed		*29.40*
3074	Mutual No. 1	Factory, Redlands	33.29
	Guaranteed		*31.00*
3300*	Shamrock	S. G. Armstrong, Riverside	**26.60**
	Guaranteed		*30.00*
3310*	Special	Mrs. M. E. Wallace, Rialto	25.05
	Guaranteed		*29.00*
	Cudahy Packing Co., South Omaha, Neb.		
2960*	Tankage	E. A. Moore, Redlands	31.02
3195*	Tankage	C. L. Clock, Redlands	29.44
	Guaranteed		*30.10*
3196*	Tankage	C. L. Clock, Redlands	31.39
	Guaranteed		*29.99*
3286*	Tankage	C. L. Clock, Redlands	32.92
	Guaranteed		*30.31*
	General Fertilizer Association, Los Angeles, Cal.		
3441	Bat Guano	Mrs. O. D. Harris, Rialto	17.45
	Guaranteed		*19.00*
3408*	Bone Flour	G. G. Laidlow, Ontario	26.89
	Guaranteed		*26.70*
3573*	Bone and Blood Meal	J. H. Payne, Upland	30.21
	Guaranteed		*28.99*

*2900—Incorrectly labeled. Sulfate of Potash added.

*3137—Discrepancy in valuation due to inadequacy in guaranty.

*3288—Discrepancy in valuation due to inadequacy in guaranty.

*3369—Discrepancy in valuation due to inadequacy in guaranty.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
2900	.....	.....	12.75	.....	1.01	.....	0.97	.....	1.98	7.23	**7.23**	.....
.....	.....	.....	*8.00*	.....	.....	.....	*2.00*	.....	*2.00*	*8.00*	*8.00*	.....
3137	.....	.....	10.65	.....	4.37	0.14	1.12	.....	5.63	.....	0.54	.....
.....	.....	.....	*10.07*	.....	.....	.....	*5.45*	.....	*5.45*	.....	*0.41*	.....
3288	.....	.....	**8.00**	.....	3.82	0.20	1.40	.....	5.42	.....	0.61	.....
.....	.....	.....	*10.00*	.....	.....	.....	*5.00*	.....	*5.00*	.....	*0.50*	.....
3368	.....	.....	**8.50**	.....	2.28	0.22	1.56	.....	4.06	.....	0.49	.....
.....	.....	.....	*12.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	*0.50*	.....
3369	.....	.....	9.05	.....	2.57	0.28	1.45	.....	4.30	.....	0.41	.....
.....	.....	.....	*10.00*	.....	.....	.....	*4.50*	.....	*4.50*	.....	*0.50*	.....
3373	.....	.....	11.40	.....	0.57	0.21	3.50	.....	4.28	.....	.....	.....
.....	.....	.....	*12.00*	.....	.....	.....	*4.35*	.....	*4.35*	.....	.....	.....
3073	.....	.....	.....	.....	.....	.....	13.97	.....	13.97	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*14.10*	.....	*14.10*	.....	.....	.....
3135	.....	.....	23.20	.....	.....	.....	4.00	.....	4.00	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*4.00*	.....	*4.00*	.....	.....	.....
3074	7.16	5.74	12.90	.....	.....	.....	5.07	.....	5.07	3.55	3.55	.....
.....	*7.00*	*5.00*	*12.00*	*Super, Bn, T*	.....	.....	*4.50*	*Bat G, Bn, T*	*4.50*	*4.00*	*4.00*	.....
3300	**6.25**	4.20	10.45	.....	3.00	0.20	2.00	.....	5.20	2.01	2.01	.....
.....	*8.00*	*4.00*	*12.00*	.....	.....	.....	*5.00*		*5.00*	*2.00*	*2.00*	.....
3310	.....	.....	10.25	.....	3.02	0.25	1.70	.....	4.97	2.23	2.23	.....
.....	.....	.....	*10.00*	.....	.....	.....	.....	.....	*5.00*	*2.00*	*2.00*	.....
2960	.....	.....	**12.00**	*Bn*	.....	.....	5.86	*Bn, Bl*	5.86	.....	.....	.....
3195	.....	.....	15.60		.....	.....	4.80		**4.80**	.....	.....	.....
.....	.....	.....	*13.50*		.....	.....	*5.35*		*5.35*	.....	.....	.....
3196	.....	.....	13.65		.....	.....	5.69		5.69	.....	.....	.....
.....	.....	.....	*13.50*		.....	.....	*5.35*		*5.35*	.....	.....	.....
3286	.....	.....	**12.15**		.....	.....	6.26		6.26	.....	.....	.....
.....	.....	.....	*13.50*		.....	.....	*5.35*		*5.35*	.....	.....	.....
3441	.....	.....	**8.10**	.....	1.91	0.15	1.55	.....	3.61	.....	.....	.....
.....	.....	.....	*10.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	.....
3408	19.68	11.82	31.50	.....	.....	.....	1.21	.....	1.21	.....	.....	.....
.....	*20.00*	*11.00*	*31.00*	.....	.....	.....	*1.25*	.....	*1.25*	.....	.....	.....
3573	.....	.....	21.80	.....	.....	.....	4.20	.....	4.20	.....	.....	.....
.....	.....	.....	*20.00*	.....	.....	.....	*4.21*	.....	*4.21*	.....	.....	.....

*3135—34% fine.

*3300—Derivations not guaranteed.

*3310—Derivations not guaranteed. Discrepancy in valuation due to inadequacy in guaranty.

*2960—73% fine.

*3195—74% fine.

*3196—70% fine.

*3286—78% fine.

*3408—97% fine.

*3573—40% fine. Some hoof.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	General Fertilizer Association —*Continued.*		
3253	G. F. A. No. 5	Riverside Hts. O. G. Assn., Riverside	31.65
3337	G. F. A. No. 5	P. J. Bollinger, Riverside	29.35
3451	G. F. A. No. 5	Riverside Hts. O. G. Assn., Riverside	30.81
	Guaranteed		*31.60*
3336	G. F. A. No. 8	P. J. Bollinger, Riverside	25.08
3412*	G. F. A. No. 8	Rialto O. & L. Assn., Rialto	20.18
3445	G. F. A. No. 8	Rialto O. & L. Assn., Rialto	21.90
	Guaranteed		*22.80*
3456	G. F. A. No. 8	A. C. Denman & Sons, Redlands	30.22
	Guaranteed		*32.60*
3406	Nitrate of Soda	G. G. Laidlow, Ontario	41.61
	Guaranteed		*40.50*
3444	Orange and Lemon No. 1	Rialto O. & L. Assn., Rialto	26.01
3467*	Orange and Lemon No. 1	F. B. Landon, San Dimas	25.19
3564	Orange and Lemon No. 1	W. B. Glidden, Glendora	27.11
3609	Orange and Lemon No. 1	B. E. Sibley, Rialto	26.07
	Guaranteed		*25.40*
3338	Special	P. J. Bollinger, Riverside	29.02
	Guaranteed		*29.70*
3362	Special	R. B. Campbell, Ontario	36.51
	Guaranteed		*33.74*
3403*	Special	A. C. Denman & Sons, Redlands	29.10
	Guaranteed		*26.80*
3417	Special	J. W. Curtis, San Bernardino	26.10
	Guaranteed		*24.85*
3442	Special	Rialto O. & L. Assn., Rialto	**25.95**
	Guaranteed		*29.05*
3468	Special	F. S. Hostetler, Lindsay	30.90
	Guaranteed		*29.96*
3567	Special	Mountain View O. & L. Assn., Upland	28.81
	Guaranteed		*30.70*
3580	Special	J. S. Grepe, East Highlands	$29.39
3581	Special	J. S. Grepe, East Highlands	29.78
	Guaranteed		*30.05*
3582*	Special	Rialto O. & L. Assn., Rialto	21.67
	Guaranteed		*25.60*
3596*	Special	A. R. Ocheltree, Riverside	33.05
	Guaranteed		*29.00*
3598*	Special	R. L. Willits, Corona	39.08
	Guaranteed		*40.02*
3383	Special No. 1	E. L. Menager, Duarte	27.08
	Guaranteed		*27.28*
3407	Sulfate of Potash	G. G. Laidlow, Ontario	**47.44**
	Guaranteed		*50.00*

3412—Discrepancy in valuation due to inadequacy in guaranty.

*3467—Pencil alterations on tags illegible and ignored.

*3582—Derivations not guaranteed.

*3596—Derivations not guaranteed.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3253	9.20	3.60	12.80		2.18	0.29	2.87		5.34	2.84	2.84	
3337	9.55	2.60	12.15		1.60	0.33	2.89		4.82	1.96	1.96	
3451	10.25	4.50	14.75		2.43	0.43	1.90		4.76	3.40	3.40	
.....	*8.00*	*4.00*	*12.00*	*Super, Bn, G*	.....	.....	.....	*Bl, Bn, G*	*5.00*	*2.00*	*2.00*	
3336	7.31	2.64	9.95		0.39	0.15	3.00		3.54	3.24	3.24	
3412	6.51	0.94	7.45		1.60	.....	1.40		3.00	3.37	3.37	0.85
3445	6.60	2.90	9.50		1.74	0.20	1.31		3.25	3.64	3.64	
.....	*7.00*	*2.00*	*9.00*		.....	.....	.....		*3.00*	*3.00*	*3.00*	
3456	**6.43**	6.32	12.75		2.36	.....	2.97		5.33	3.01	3.01	
.....	*8.00*	*4.00*	*12.00*		.....	.....	.....		*5.00*	*3.00*	*3.00*	
3406	.....	.....	.....	.....	15.41	.....	.....	.....	15.41	.....	.....	
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	
3444	6.74	3.26	10.00		2.03	0.20	1.75		3.98	4.93	4.93	
3467	7.13	3.42	10.55		2.07	0.12	2.09		4.28	2.40	**2.40**	
3564	7.25	3.10	10.35		1.96	0.15	2.06		4.17	4.67	4.67	0.82
3609	6.62	3.48	10.10		1.94	0.13	1.97		4.04	4.58	4.58	0.71
.....	*5.00*	*5.00*	*10.00*	*Super, Bn*	*2.00*	.....	*2.00*	*Bl, Bn, G*	*4.00*	*5.00*	*5.00*	
3338	8.44	3.96	12.40		3.42	0.14	1.89		5.45	1.82	1.82	
.....	*7.00*	*3.00*	*10.00*		.....	.....	.....		*5.00*	*1.50*	*1.50*	
3362	7.88	4.12	12.00		.....	.....	5.45		5.45	.....	5.18	1.35
.....	.....	.....	*11.25*		.....	.....	*5.25*		*5.25*	.....	*4.87*	
3403	5.97	4.88	10.85		2.24	0.24	2.68		5.16	3.74	3.74	
.....	*6.00*	*6.00*	*12.00*		*2.00*	.....	*2.50*		*5.00*	*3.00*	*3.00*	
3417	.....	.....	11.50	.....	2.88	0.17	1.76	.....	**4.81**	2.75	2.75	
.....	.....	.....	*10.00*	.....	*5.50*	.....	.....	.....	*5.50*	*3.00*	*3.00*	
3442	**6.33**	3.32	9.65		2.27	0.22	1.51		**4.00**	5.50	5.50	
.....	*7.50*	*2.50*	*10.00*	*Super, Bn*	*1.50*	.....	*3.50*	*Bl, Bn, G*	*5.00*	*2.50*	*2.50*	
3468	8.23	1.92	10.15		.....	.....	4.20		4.20	4.91	4.91	
.....	*8.50*	.....	.....		.....	.....	*4.35*		*4.35*	*4.06*	*4.06*	
3567	8.05	3.60	11.65		2.84	.....	2.12		4.96	3.17	3.17	0.80
.....	*8.00*	*4.00*	*12.00*		.....	.....	.....		*4.50*	*3.10*	*3.10*	
3580	.....	.....	12.05	.....	0.30	0.44	4.73	.....	5.47	.....	0.43	
3581	.....	.....	12.05	.....	0.62	.....	4.92	.....	5.54	.....	0.41	
.....	.....	.....	*11.50*	*Bn, T*	.....	.....	*5.50*	*Bat G, Bl. Bn*	*5.50*	.....	*0.25*	
3582	.....	.....	8.10	.....	2.52	0.15	1.25	.....	3.92	.....	3.78	
.....	.....	.....	*8.00*	.....	.....	.....	.....	.....	*4.00*	.....	*4.00*	
3596	6.10	3.80	9.90	.....	1.74	0.13	4.45	.....	6.32	.....	2.57	0.70
.....	.....	.....	*10.00*	.....	.....	.....	.....	.....	*5.00*	.....	*2.00*	
3598	.....	.....	14.65	.....	0.11	0.20	6.40	.....	**6.71**	.....	**2.37**	
.....	.....	.....	*9.00*	.....	.....	.....	.....	.....	*7.68*	.....	*3.00*	
3383	8.74	2.86	11.60	.....	2.08	0.12	2.22	.....	4.42	2.37	2.37	
.....	*8.00*	*2.00*	*10.00*	.....	.....	.....	.....	.....	*4.12*	*2.00*	*2.00*	
3407	.....	.....	.....	.....	.....	.....	.....	.....	.....	47.44	**47.44**	1.84
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*50.00*	*50.00*	

*3403—0.5% of nitrogen not accounted for in guaranty. *3598—Derivations not guaranteed.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	General Fertilizer Association —*Continued.*		
3446	Superphosphate	Rialto O. & L. Assn., Rialto	21.96
	Guaranteed		*20.80*
3357*	Tankage	Riverside Hts. O. G. Assn., Riverside	.....
3450*	Tankage	Riverside Hts. O. G. Assn., Riverside	.....
	Sold on Station Analysis.		
3433*	Tankage	Riverside Hts. O. G. Assn., Riverside	37.87
	Guaranteed		*38.27*
3552*	Tankage	Riverside Hts. O. G. Assn., Riverside	38.31
	Guaranteed		*37.02*
3553*	Tankage	Riverside Hts. O. G. Assn., Riverside	37.39
	Guaranteed		*37.86*
3577*	Tankage	Riverside Hts. O. G. Assn., Riverside	37.01
	Guaranteed		*37.90*
3586*	Tankage	Bloomington Fruit Assn., Bloomington	40.01
	Guaranteed		*40.16*
	Hauser Packing Co., Los Angeles, Cal.		
3214	Blood	Covina Citrus Assn., Covina	.....
3359	Blood	Azusa Citrus Assn., Azusa	.....
3554	Blood	M. M. Seabolt, Bloomington	.....
	Sold on Station Analysis.		
3236*	Tankage	Rev. E. F. Goff, Claremont	.....
3237*	Tankage	Rev. E. F. Goff, Claremont	.....
3241*	Tankage	Bloomington Fruit Assn., Bloomington	.....
3242*	Tankage	Bloomington Fruit Assn., Bloomington	.....
3299*	Tankage	Covina Citrus Assn., Covina	.....
3333*	Tankage	Corona Lemon Co., Corona	.....
3334*	Tankage	Corona Lemon Co., Corona	.....
3343*	Tankage	Hugh Latimer, Arlington	.....
3345*	Tankage	Hugh Latimer, Arlington	.....
3348*	Tankage	Bloomington Fruit Assn., Bloomington	.....
3352*	Tankage	Bloomington Fruit Assn., Bloomington	.....
3353*	Tankage	Bloomington Fruit Assn., Bloomington	.....
3414*	Tankage	W. H. Robinson, Riverside	.....
3425*	Tankage	E. F. Wolever, Highgrove	.....
3436*	Tankage	Benchley Fruit Co., Fullerton	.....
3459*	Tankage	Covina Citrus Assn., Covina	.....
3555*	Tankage	M. M. Seabolt, Bloomington	.....
3556*	Tankage (dust)	M. M. Seabolt, Bloomington	.....
3557*	Tankage	M. M. Seabolt, Bloomington	.....
	Sold on Station Analysis.		

*3357—58% fine.
*3450—78% fine.
*3433—78% fine.
*3552—71% fine.
*3553—70% fine.
*3577—72% fine.
*3586—83% fine.
*3236—63% fine.
*3237—98% fine.
*3241—53% fine.
*3242—41% fine.
*3299—54% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3446	21.96	0.24	22.20									
.....	*20.80*	.....	.....									
3357	.....	.....	9.20		.....	.....	7.75		7.75	.....	.....	.....
3450	.....	.....	17.16		.....	.....	6.14		6.14	.....	.....	.....
3433	.....	.....	13.60				7.27		7.27			
.....	.....	.....	*13.50*		.....	.....	*7.39*		*7.39*			
3552	.....	.....	8.75		.....	.....	8.38		8.38	.....	.....	.....
.....	.....	.....	*9.00*		.....	.....	*8.00*		*8.00*			
3553	.....	.....	13.10		.....	.....	7.35		7.35	.....	.....	.....
.....	.....	.....	*13.50*		.....	.....	*7.40*		*7.40*			
3577	.....	.....	**6.25**		.....	.....	8.50		8.50	.....	.....	.....
.....	.....	.....	*9.00*		.....	.....	*8.23*		*8.23*			
3586	.....	.....	7.35		.....	.....	8.85		8.85	.....	.....	.....
.....	.....	.....	*7.39*	*Bn*	.....	.....	*8.88*	*Bl, Bn*	*8.88*			
3214	.....	.....	.....	.....	.....	.....	12.78	.....	12.78	.....	.....	.....
3359	.....	.....	.....	.....	.....	.....	12.68	.....	12.68	.....	.....	.....
3554	.....	.....	.....	.....	.....	.....	12.00	.....	12.00	.....	.....	.....
3236	.....	.....	12.80		.....	.....	5.11		5.11	.....		
3237	.....	.....	13.00		.....	.....	6.49		6.49	.....	.....	.....
3241	.....	.....	6.40		.....	.....	4.70		4.70	.....	.....	.....
3242	.....	.....	7.15		.....	.....	5.05		5.05	.....	.....	.....
3299	.....	.....	16.10		.....	.....	4.40		4.40	.....	.....	.....
3333	.....	.....	12.25		.....	.....	6.26		6.26	.....	.....	.....
3334	.....	.....	18.50		.....	.....	4.71		4.71	.....	.....	.....
3343	.....	.....	15.90		.....	.....	4.40		4.40	.....	.....	.....
3345	.....	.....	17.00		.....	.....	4.47		4.47	.....	.....	.....
3348	.....	.....	5.70		.....	.....	3.94		3.94	.....	.....	.....
3352	.....	.....	6.35		.....	.....	5.45		5.45	.....	.....	.....
3353	.....	.....	19.50		.....	.....	3.78		3.78	.....	.....	.....
3414	.....	.....	16.95		.....	.....	5.94		5.94	.....	.....	.....
3425	.....	.....	16.40		.....	.....	4.55		4.55	.....	.....	.....
3436	.....	.....	16.00		.....	.....	4.48		4.48	.....	.....	.....
3459	.....	.....	16.75		.....	.....	4.37		4.37	.....	.....	.....
3555	.....	.....	20.00		.....	.....	3.90		3.90	.....	.....	.....
3556	.....	.....	13.45		.....	.....	5.73		5.73	.....	.....	.....
3557	.....	.....	16.00	*Bn*	.....	.....	5.04	*Bl, Bn*	5.04	.....	.....	.....

*3333—58% fine.
*3334—66% fine.
*3343—51% fine.
*3345—55% fine.
*3348—77% fine.
*3352—43% fine.
*3353—68% fine.
*3414—69% fine
*3425—56% fine.
*3436—54% fine.
*3459—58% fine.
*3555—69% fine.
*3556—86% fine.
*3557—70% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Hawaiian Fertilizer Co., San Francisco, Cal.		
3550	Fruit and Vine	M. Braughler, Santa Rosa	26.50
	Guaranteed		*24.50*
3535*	Special	Johnson & Wilson, Ceres	11.96
	Guaranteed		*14.00*
3534	Superphosphate	Johnson & Wilson, Ceres	18.50
	Guaranteed		*17.00*
	Thomas Lewis, Sacramento, Cal.		
3480*	Tom Lewis Fertilier	R. D. Williams, Exeter	.....
3538*	Tom Lewis Fertilizer	J. W. Sollars, Lodi	.....
	Los Angeles Fertilizer Co., Los Angeles, Cal.		
2945*	Bone Meal	Factory, Los Angeles	28.14
	Guaranteed		*25.30*
3200	Browns Special Lawn No. 1	Live Hardware Co., S. Pasadena	22.72
3233*	Browns Special Lawn No. 1	Valley Supply Co., Glendale	21.28
	Guaranteed		*22.20*
2944	Fruit Grower	Factory, Los Angeles	22.62
	Guaranteed		*20.11*
2987	Special	C. V. Lambrigger, Upland	36.27
	Guaranteed		*34.90*
3068	Special	Carrol B. Smith, Redlands	31.12
	Guaranteed		*31.40*
3132*	Special	W. T. Schaffner, Upland	35.53
	Guaranteed		*34.60*
3169*	Special	Benchley Fruit Co., Fullerton	24.21
	Guaranteed		*25.00*
3382	Special	Wm. Rohrig, Upland	33.48
	Guaranteed		*31.00*
3474	Special	Jas. N. Reynolds, Lindsay	26.48
	Guaranteed		*25.55*
3495	Special	Jas. N. Reynolds, Lindsay	27.92
	Guaranteed		*25.25*
2946*	Tankage	Factory, Los Angeles	27.53
	Guaranteed		*26.20*
3066*	Tankage	Carrol B. Smith, Redlands	38.63
	Guaranteed		*37.61*

*3535—Chlorin excessively high. Potash probably derived from Kainit. Availability of phosphoric acid not stated.

*3480—Not properly labeled. Negligible quantities of plant foods present.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3550	8.35	0.90	9.25	.....	2.21	1.10	0.71	.....	4.02	5.90	**5.90**	0.80
.....	*7.00*	*1.00*	*8.00*	.....	*1.00*	*0.50*	*1.00*	.....	*2.50*	*9.00*	*9.00*	.....
3535	7.55	2.20	9.75	.....	.....	.....	.....	.....	.....	.....	5.49	18.20
.....	.....	.....	*10.00*	*Super*	.....	.....	.....	.....	.....	*5.00*	*5.00*	.....
3534	18.50	0.40	18.90	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*17.00*	*0.50*	*17.50*	.....	.....	.....	.....	.....	.....	.....	.....	.....
3480	.....	.....	2.25	.....	.....	.....	0.88	.....	0.88	.....	0.40	.....
3538	.....	.....	1.65	.....	.....	.....	1.09	.....	1.09	.....	0.33	.....
2945	.....	.....	23.60	.....	.....	.....	3.16	.....	3.16	.....	.....	.....
.....	.....	.....	*23.00*	.....	.....	.....	*2.50*	.....	*2.50*	.....	.....	.....
3200	3.76	3.44	7.20	.....	.....	.....	3.85	.....	3.85	2.19	2.19	.....
3233	3.45	4.00	7.45	.....	.....	.....	3.45	.....	**3.45**	2.43	2.43	.....
.....	*3.00*	*3.00*	*6.00*	*Super, Bn, T*	.....	.....	*4.00*	*Bl, Bn, H, T.*	*4.00*	*2.00*	*2.00*	.....
2944	6.93	2.22	9.15	.....	1.54	0.12	1.70	.....	3.36	3.52	3.52	.....
.....	*6.00*	*2.00*	*8.00*	*Super, Bn, T*	*0.75*	*0.60*	*1.65*	*Bl, Bn, T*	*3.00*	*3.00*	*3.00*	.....
2987	.....	.....	18.60	*Bn, T*	.....	.....	3.46	*Bn, T*	3.46	9.41	**9.41**	.....
.....	.....	.....	*17.00*		.....	.....	*3.25*		*3.25*	*10.00*	*10.00*	.....
3068	.....	.....	11.85		.....	.....	3.80		3.80	7.63	7.63	0.70
.....	.....	.....	*12.00*		.....	.....	*4.00*		*4.00*	*7.00*	*7.00*	.....
3132	.....	.....	17.60		.....	.....	3.22		3.22	.....	10.33	3.20
.....	.....	.....	*18.00*		.....	.....	*3.50*		*3.50*	*8.00*	*8.00*	.....
3169	7.95	0.30	8.25	.....	4.13	.....	0.20	.....	4.33	4.19	4.19	.....
.....	*7.00*	.....	.....	.....	.....	.....	*4.00*	.....	*4.00*	*2.00*	*2.00*	.....
3382	7.77	5.78	13.55	*Super, Bn*	.....	.....	4.41	*Bn, T*	4.41	5.76	5.76	0.62
.....	*8.00*	*5.00*	*13.00*		.....	.....	*4.00*		*4.00*	*5.00*	*5.00*	.....
3474	7.46	2.54	10.00		1.34	0.18	1.54		3.06	7.47	7.47	0.70
.....	*7.00*	*3.00*	*10.00*		*1.50*	.....	*1.50*		*3.00*	*7.00*	*7.00*	.....
3495	8.90	2.60	11.50		1.21	.....	1.84		3.05	7.35	7.35	.....
.....	*7.00*	*3.00*	*10.00*		*1.50*	.....	*1.50*		*3.00*	*7.00*	*7.00*	.....
2946	.....	.....	10.05	*Bn*	.....	.....	5.34	*Bl, Bn*	5.34	.....	.....	.....
.....	.....	.....	*10.00*		.....	.....	*5.00*		*5.00*	.....	.....	.....
3066	.....	.....	10.60		.....	.....	8.39		8.39	.....	.....	.....
.....	.....	.....	*10.17*		.....	.....	*8.20*		*8.20*	.....	.....	.....

*3538—Not properly labeled. Negligible quantities of plant foods present.

*2945—53% fine.

*3233—Raw hoof paring present.

*3132—Some hoof. Chlorin content high.

*3169—Derivations not guaranteed.

*2946—71% fine.

*3066—58% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Los Angeles Fertilizer Co.— *Continued.*		
3067*	Tankage	Carroll B. Smith, Redlands	$31.64
	Guaranteed		*30.60*
3170*	Tankage	Benchley Fruit Co., Fullerton	35.23
	Guaranteed		*35.08*
3202*	Tankage	C. C. Chapman, Fullerton	36.01
	Guaranteed		*34.72*
3203*	Tankage	C. C. Chapman, Fullerton	35.70
	Guaranteed		*34.24*
3204*	Tankage	C. C. Chapman, Fullerton	36.04
	Guaranteed		*34.12*
3427*	Tankage	G. W. Hall, Glendora	34.28
	Guaranteed		*34.48*
3443*	Tankage	Glendora Citrus Assn., Glendora	.....
3454*	Tankage	Glendora Citrus Assn., Glendora	.....
3563*	Tankage	Glendora Citrus Assn., Glendora	.....
	Sold on Station Analysis.		
3605*	Three Queens Tankage	Windermere Ranch, La Mirada	.....
	Sold on Station Analysis.		
3367	Three Queens Spcl. Frt. Grower	F. W. Jonas, Rialto	28.50
	Guaranteed		*26.60*
	Mapes Formula and Peruvian Guano Co., New York, N. Y.		
3083	Orange Tree Manure	J. J. Prendergast, Redlands	23.37
	Guaranteed		*19.66*
	Morris & Company, Chicago, Ill.		
3206	Blood	C. C. Chapman, Fullerton	58.84
3365	Blood	Fitzgerald & Barry, Pasadena	**57.07**
3416	Blood	C. O. Baughman, Claremont	59.22
3431	Blood	Limoneira Co., Santa Paula	**57.08**
	Guaranteed		*58.80*
3084	Pacific Big 1	W. D. Bethell, Redlands	26.50
	Guaranteed		*26.88*
3097*	Pacific Big 2	Benchley Fruit Co., Fullerton	30.50
3239*	Pacific Big 2	Fitzgerald & Barry, Pasadena	29.60
3366*	Pacific Big 2	Fitzgerald & Barry Pasadena	29.42
	Guaranteed		*29.08*
3111*	Pacific Big 2	Sweetwater Fruit Co., Bonita	29.34
3112*	Pacific Big 2	Sweetwater Fruit Co., Bonita	28.74
3115*	Pacific Big 2	San Diego Fruit Co., San Diego	29.17
	Guaranteed		*29.03*
3430*	Pacific Big 2	Limoneira Co., Santa Paula	29.87
	Guaranteed		*29.28*

*3067—58% fine.
*3170—87% fine. Some hoof.
*3202—79% fine.
*3203—72% fine.
*3204—69% fine.
*3427—75% fine.
*3443—81% fine.
*3454—78% fine.
*3563—49% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3067	.....	.....	18.90	*Bn*	.....	.....	4.95	*Bl, Bn*	4.95	.....	.....	.....
.....	.....	.....	*18.44*		.....	.....	*4.76*		*4.76*	.....	.....	.....
3170	.....	.....	15.95		.....	.....	6.05		6.05	.....	.....	.....
.....	.....	.....	*16.00*		.....	.....	*6.00*		*6.00*	.....	.....	.....
3202	.....	.....	15.55		.....	.....	6.41		6.41	.....	.....	.....
.....	.....	.....	*16.00*		.....	.....	*6.00*		*6.00*	.....	.....	.....
3203	.....	.....	17.55		.....	.....	6.10		6.10	.....	.....	.....
.....	.....	.....	*16.00*		.....	.....	*6.00*		*6.00*	.....	.....	.....
3204	.....	.....	17.45		.....	.....	6.24		6.24	.....	.....	.....
.....	.....	.....	*16.00*		.....	.....	*6.00*		*6.00*	.....	.....	.....
3424	.....	.....	16.50		.....	.....	5.86		5.86	.....	.....	.....
.....	.....	.....	*16.00*		.....	.....	*6.00*		*6.00*	.....	.....	.....
3443	.....	.....	15.40		.....	.....	6.25		6.25	.....	.....	.....
3454	.....	.....	14.75		.....	.....	6.47		6.47	.....	.....	.....
3563	.....	.....	16.75		.....	.....	5.75		5.75	.....	.....	.....
3605	.....	.....	19.70		.....	.....	5.25		5.25	.....	.....	.....
3367	8.76	2.64	11.40	.....	1.72	0.10	2.42	.....	4.24	4.08	4.08	.....
.....	*8.00*	*2.00*	*10.00*	*Super Bn, T*	*1.00*	*0.75*	*2.25*	*Bl, Bn, T*	*4.00*	*4.00*	*4.00*	.....
3083	7.14	3.36	10.50	.....	1.44	1.58	0.74	.....	3.76	3.63	3.63	.....
.....	*6.00*	*2.00*	*8.00*	.....	*2.40*	*0.15*	*0.74*	.....	*3.29*	3.00	3.00	.....
3206	.....	.....	.....	.....	.....	.....	14.01	.....	14.01	.....	.....	.....
3365	.....	.....	.....	.....	.....	.....	13.59	.....	**13.59**	.....	.....	.....
3416	.....	.....	.....	.....	.....	.....	14.10	.....	14.10	.....	.....	.....
3431	.....	.....	.....	.....	.....	.....	13.59	.....	**13.59**	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*14.00*	.....	*14.00*	.....	.....	.....
3084	.....	.....	27.00	*Bn*	.....	.....	0.84	*Bn*	0.84	4.24	4.24	.....
.....	.....	.....	*28.00*		.....	.....	*0.82*		*0.82*	4.00	4.00	.....
3097	.....	.....	27.50		.....	.....	2.93		2.93	.....	.....	.....
3239	.....	.....	27.70		.....	.....	2.66		2.66	.....	.....	.....
3366	.....	.....	27.50		.....	.....	2.65		2.65	.....	.....	.....
.....	.....	.....	*28.00*		.....	.....	*2.47*		*2.47*	.....	.....	.....
3111	.....	.....	28.00		.....	.....	2.55		2.55	.....	.....	.....
3112	.....	.....	27.20		.....	.....	2.54		2.54	.....	.....	.....
3115	.....	.....	28.30		.....	.....	2.45		2.45	.....	.....	.....
.....	.....	.....	*28.00*		.....	.....	*2.47*		*2.47*	.....	.....	.....
3430	.....	.....	28.00		.....	.....	2.62		2.62	.....	.....	.....
.....	.....	.....	*28.00*		.....	.....	*2.47*		*2.47*	.....	.....	.....

*3065—72% fine. Some hoof.
*3097—72% fine.
*3239—72% fine.
*3366—71% fine.
*3111—68% fine.
*3112—68% fine.
*3115—68% fine.
*3430—81% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Morris & Co.—*Continued.*		
3098*	Pacific Big 4	Benchley Fruit Co., Fullerton	42.98
3136*	Pacific Big 4	Glendora Citrus Assn., Glendora	41.40
3354*	Pacific Big 4	Bloomington Fruit Assn., Bloomington	42.74
3401*	Pacific Big 4	A. P. Griffith, Azusa	41.72
3440*	Pacific Big 4	A. E. Rutledge, Monrovia	41.55
	Guaranteed		*42.18*
3185*	Pacific Big 4	Frank L. Palmer, North Pomona	43.20
3186*	Pacific Big 4	Frank L. Palmer, North Pomona	42.47
3187*	Pacific Big 4	Frank L. Palmer, North Pomona	42.22
	Guaranteed		*42.78*
3252*	Pacific Big 4	Riverside Hts. O. G. Assn., Riverside	40.92
3387*	Pacific Big 4	Orange Hts. Fruit Assn., Corona	43.01
	Guaranteed		*41.99*
3360*	Pacific Big 4	Azusa Citrus Assn., Azusa	43.21
3386*	Pacific Big 4	Orange Hts. Fruit Assn., Corona	43.24
	Guaranteed		*42.58*
3372*	Pacific Big 4	Highgrove Fruit Exchange, Highgrove	41.24
	Guaranteed		*41.59*
3426	Pacific Big 5	C. O. Baughman, Claremont	41.75
	Guaranteed		*40.42*
3085*	Pacific Big 6	W. D. Bethell, Redlands	23.91
	Guaranteed		*22.72*
3131*	Pacific Big 6	Glendora Citrus Assn., Glendora	23.02
	Guaranteed		*22.65*
3361*	Pacific Big 6	Azusa Citrus Assn., Azusa	24.09
	Guaranteed		*22.68*
3086	Pacific Big 8	W. D. Bethell, Redlands	33.81
	Guaranteed		*31.50*
	Mountain Copper Co., San Francisco, Cal.		
3532*	*0–3–3*	The Grange Co., Modesto	7.29
	Guaranteed		*6.00*
3531*	*0–5–0*	The Grange Co., Modesto	7.60
	Guaranteed		*5.00*
3530	*0–9–8*	The Grange Co., Modesto	18.43
	Guaranteed		*17.00*
3498	*3–10–2*	Lindsay Mercantile Co., Lindsay	23.75
3548	*3–10–2*	A. Hatt, Napa	22.97
	Guaranteed		*21.60*
3520	*4–10–1½*	A. T. Botts, Palermo	27.09
	Guaranteed		*24.23*
3229	*4–10–4*	Sparr Fruit Co., Los Angeles	28.83
3497	*4–10–4*	Lindsay Mercantile Co., Lindsay	2887
	Guaranteed		*2628*

*3098—76% fine.
*3136—75% fine.
*3354—76% fine.
*3401—75% fine.
*3440—76% fine.
*3185—83% fine.
*3186—83% fine.
*3187—83% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3098	.....	.....	**3.55**		.....	.....	10.44		10.44	.....	.....	.....
3136	.....	.....	**3.95**		.....	.....	9.96		9.96	.....	.....	.....
3354	.....	.....	4.80		.....	.....	10.15		10.15	.....	.....	.....
3401	.....	.....	4.95		.....	.....	9.86		9.86	.....	.....	.....
3440	.....	.....	5.15		.....	.....	9.78		9.78	.....	.....	.....
.....	.....	.....	*5.50*		.....	.....	*9.88*		*9.88*	.....	.....	.....
3185	.....	.....	5.15		.....	.....	10.05		10.05	.....	.....	.....
3186	.....	.....	5.00		.....	.....	9.89		9.89	.....	.....	.....
3187	.....	.....	5.15		.....	.....	9.80		9.80	.....	.....	.....
.....	.....	.....	*5.50*	*T*	.....	.....	*9.88*	*T*	*9.88*	.....	.....	.....
3252	.....	.....	5.25		.....	.....	9.65		9.65	.....	.....	.....
3387	.....	.....	4.55		.....	.....	10.32		10.32	.....	.....	.....
.....	.....	.....	*5.50*		.....	.....	*9.88*		*9.88*	.....	.....	.....
3360	.....	.....	4.55		.....	.....	10.21		10.21	.....	.....	.....
3386	.....	.....	5.00		.....	.....	10.14		10.14	.....	.....	.....
.....	.....	.....	*5.50*		.....	.....	*9.88*		*9.88*	.....	.....	.....
3372	.....	.....	4.90		.....	.....	9.90		9.90	.....	.....	.....
.....	.....	.....	*5.50*		.....	.....	*9.88*		*9.88*	.....	.....	.....
3426	.....	.....	5.35		.....	.....	8.55		8.55	3.81	3.81	.....
.....	.....	.....	*5.00*		.....	.....	*8.23*		*8.23*	*4.00*	*4.00*	.....
3085	.....	.....	29.00		.....	.....	0.95		0.95	.....	.....	.....
.....	.....	.....	*28.00*		.....	.....	*0.82*		*0.82*	.....	.....	.....
3131	.....	.....	28.80		.....	.....	0.77		0.77	.....	.....	.....
.....	.....	.....	*28.00*		.....	.....	*0.82*		*0.82*	.....	.....	.....
3361	.....	.....	28.50	*Bn*	.....	.....	1.10	*Bn*	1.10	.....	.....	.....
.....	.....	.....	*28.00*		.....	.....	*0.82*		*0.82*	.....	.....	.....
3086	.....	.....	**22.20**		.....	.....	3.47		3.47	4.39	4.39	.....
.....	.....	.....	*25.00*		.....	.....	*2.50*		*2.50*	*4.00*	*4.00*	.....
3532	4.39	0.16	4.55		.....	.....	.....	.....	.....	2.90	2.90	.....
.....	*3.00*	*0.50*	*3.50*		.....	.....	.....	.....	.....	*3.00*	*3.00*	.....
3531	7.60	0.70	8.30	*Super*	.....	.....	.....	.....	.....	.....	.....	.....
.....	*5.00*	*0.20*	*5.20*		.....	.....	.....	.....	.....	.....	.....	.....
3530	10.86	1.14	12.00		.....	.....	.....	.....	.....	7.57	7.57	.....
.....	*9.00*	*0.50*	*9.50*		.....	.....	.....	.....	.....	*8.00*	*8.00*	.....
3498	10.20	0.40	10.60		2.23	.....	1.18		3.41	2.65	2.65	.....
3548	10.54	0.46	11.00		2.29	.....	0.89		3.18	2.51	2.51	.....
.....	*10.00*	*0.50*	*10.50*		*2.00*	.....	*1.00*		*3.00*	*2.00*	*2.00*	.....
3520	10.97	0.58	11.55	*Super*	3.03	.....	1.22	*Bl*	4.25	2.83	2.83	.....
.....	*10.00*	*0.50*	*10.50*		*2.67*	.....	*1.33*		*4.00*	*1.50*	*1.50*	.....
.....	9.74	0.26	10.00		2.79	.....	1.68		4.47	4.80	4.80	.....
3430	10.34	0.56	10.90		2.89	.....	1.40		4.29	4.47	4.47	.....
.....	*10.00*	*0.50*	*10.50*		*2.67*	.....	*1.33*		*4.00*	*4.00*	*4.00*	.....

*2—74% fine.
*3687—73% fine.
*3360—79% fine.
*3386—79% fine.
*3372—69% fine.
*3085—66% fine.
*3131—58% fine.
*3361—62% fine.

*3532—Valuation does not include gypsum.
*3531—Valuation does not include gypsum.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Mountain Copper Co.— *Continued.*		
2911	Superphosphate	Corona Lemon Co., Corona	17.96
2920	Superphosphate	Sparr Fruit Co., Los Angeles	18.20
3158	Superphosphate	Smith & Miner, Santa Ana	18.50
	Guaranteed		*17.49*
2921	Superphosphate	Sparr Fruit Co., Los Angeles	18.44
	Guaranteed		*17.30*
2922	Superphosphate	Sparr Fruit Co., Los Angeles	17.90
	Guaranteed		*17.39*
2984	Superphosphate	J. M. Mylne, Riverside	.....
	Sold on Station Analysis.		
3043	Superphosphate	Fitzgerald & Barry, Pasadena	17.18
3108	Superphosphate	H. P. Greene, San Diego	17.74
	Guaranteed		*17.34*
3163	Superphosphate	John P. Dunn, Monrovia	18.78
	Guaranteed		*17.35*
3205	Superphosphate	C. C. Chapman, Fullerton	18.64
	Guaranteed		*18.25*
3230	Superphosphate	Sparr Fruit Co., Los Angeles	17.90
3270	Superphosphate	Redlands Fruit Assn., Redlands	17.84
	Guaranteed		*17.55*
3335	Superphosphate	Sparr Fruit Co., Los Angeles	18.14
	Guaranteed		*17.40*
3499	Superphosphate	Lindsay Mercantile Co., Lindsay	18.46
	Guaranteed		*17.50*
3533	Superphosphate	The Grange Co., Modesto	18.56
	Guaranteed		*17.80*
	Nitrate Agencies Co., Los Angeles, Cal.		
2919	Nitrate of Soda	Sparr Fruit Co., Los Angeles	41.23
3106	Nitrate of Soda	H. P. Greene, San Diego	40.77
3232	Nitrate of Soda	Sparr Fruit Co., Los Angeles	41.60
3379	Nitrate of Soda	Fitzgerald & Barry, Pasadena	41.44
3505	Nitrate of Soda	H. C. Carr, Porterville	42.36
	Guaranteed		*40.50*
3055	Nitrate of Soda	A. P. Johnson, Los Angeles	**41.23**
	Guaranteed		*42.25*
	Pacific Bone, Coal & Fertilizer Co., San Francisco, Cal.		
3502	Citrona	Porterville Citrus Assn., Porterville	26.34
	Guaranteed		*25.25*
3500	Lupine	Porterville Citrus Assn., Porterville	19.54
3540	Lupine	Penryn Fruit Co., Penryn	19.99
	Guaranteed		*19.90*
3475	Nitrate of Soda	W. R. Park, Lemon Cove	41.82
3504	Nitrate of Soda	C. T. Meloy, Porterville	40.80
	Guaranteed		*40.50*
3501	Nursery Special	Porterville Citrus Assn., Porterville	27.65
	Guaranteed		*27.44*

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
2911	17.96	1.04	19.00									
2920	18.20	0.90	19.10									
3158	18.50	0.50	19.00									
.....	*17.49*	*0.58*	*18.07*									
2921	18.44	0.56	19.00									
.....	*17.30*	*0.64*	*17.94*									
2922	17.90	0.60	18.50									
.....	*17.39*	*0.62*	*18.01*									
2984	22.30	0.30	22.60									
3043	17.18	0.72	17.90									
3108	17.74	0.76	18.50									
.....	*17.34*	*0.69*	*18.03*									
3163	18.78	0.52	19.30									
.....	*17.35*	*0.45*	*17.80*									
3205	18.64	0.46	19.10									
.....	*18.25*	*0.35*	*18.60*									
3230	17.90	0.40	18.30									
3270	17.84	0.36	18.20									
.....	*17.55*	*0.50*	*18.05*									
3335	18.14	0.36	18.50									
.....	*17.40*	*0.60*	*18.00*									
3499	18.46	0.54	19.00									
.....	*17.50*	*0.45*	*17.95*									
3533	18.56	0.34	18.90									
.....	*17.80*	*0.40*	*18.20*									
2919					15.27				15.27			
3106					15.10				15.10			
3232					15.41				15.41			
3379					15.35				15.35			
3505					15.69				15.69			
.....					*15.00*				*15.00*			
3055					15.27				**15.27**			
.....					*15.65*				*15.65*			
3502	7.66	3.54	11.20		1.59	0.12	1.35		3.06	7.24	7.24	0.67
.....	*7.00*	*3.00*	*10.00*	*Supr, Bn*	*1.50*		*1.50*	*Bl, Bn, T*	*3.00*	*7.00*	*7.00*	
3500	10.00	1.30	11.30							9.54	9.54	0.64
3540	10.49	0.86	11.35							9.50	9.50	0.70
.....	*9.00*	*1.00*	*10.00*	*Super*						*10.00*	*10.00*	
3475					15.49				15.49			
3504					15.13				15.13			
					15.00				*15.00*			
3501	7.43	3.92	11.35		2.49		1.91		4.40		4.29	1.75
	7.00	*3.00*	*10.00*	*Super*	*2.43*		*2.17*	*Bl, Bn, T*	*4.60*	*4.00*	*4.00*	

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Pacific Bone, Coal & Fertilizer Co.—*Continued.*		
3476	Orange and Lemon Special	W. R. Park, Lemon Cove	28.76
3478	Orange and Lemon Special	J. S. Dungan, Lemon Cove	28.20
	Guaranteed		*26.75*
3503	Pomona	C. T. Meloy, Porterville	27.21
	Guaranteed		*25.85*
3134	Special	T. P. Spiers, San Jose	24.17
	Guaranteed		*23.00*
3469	Special	A. P. Graybill, Lindsay	30.71
	Guaranteed		*28.60*
3477	Special	Ohio Lemon Co., Lemon Cove	28.33
	Guaranteed		*27.90*
3486	Special	W. A. Veith, Fresno	30.22
	Guaranteed		*29.58*
	Pacific Guano & Fertilizer Co., San Francisco, Cal.		
3528	Basic 1	Chas. Fellows, Modesto	**12.18**
	Guaranteed		*13.50*
3527	Basic 2	Chas. Fellows, Modesto	**6.20**
3539	Basic 2	McKee & Reynolds, Ripon	9.32
	Guaranteed		*10.00*
3228	Bat Guano	Chas. Reber, San Bernardino	.....
3296	Bat Guano	W. C. McCully, Corona	.....
3344	Bat Guano	R. T. Nelson, Upland	.....
3381	Bat Guano	J. S. Wheeler, Bloomington	.....
3384	Bat Guano	W. C. McCully, Corona	.....
3562	Bat Guano	R. T. Nelson, Upland	.....
3569	Bat Guano	J. S. Benner, Rialto	.....
	Sold on Station Analysis.		
3277	Blood	Isaac Jones, San Bernardino	.....
	Sold on Station Analysis.		
3340	Blood	B. L. Byer, Upland	57.03
	Guaranteed		*56.70*
3071*	Bone Meal	Carlsbad Guano & Fert. Co., Redlands	30.44
	Guaranteed		*28.94*
3090*	Bone Meal	H. C. Rumohr, Redlands	30.75
	Guaranteed		*30.09*
3177**	Bone Meal	Covina Citrus Assn., Covina	29.45
	Guaranteed		*30.36*
3208*	Bone Meal	C. A. Ferguson, Colton	30.23
	Guaranteed		*29.02*
3226*	Bone Meal	B. S. Casey, Rialto	30.59
	Guaranteed		*29.02*
3278	Diamond N	H. C. Rumohr, Redlands	24.68
3341	Diamond N	B. L. Byer, Upland	25.80
	Guaranteed		*25.10*
3287	Diamond S	W. B. Reid, Rialto	33.35
	Guaranteed		*31.80*
3452	Diamond S	B. S. Casey, Rialto	30.66
	Guaranteed		*30.50*

*3071—38% fine. *3090—43% fine. *3208—43% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3476	7.15	1.60	8.75	.....	1.77	0.14	1.43	.....	3.34	.....	10.08	2.20
3478	6.15	3.60	9.75	.....	1.64	.....	1.61	.....	3.25	9.74	9.74	.....
.....	*5.50*	*3.00*	*8.50*	*Supr, Bn*	*1.50*	.....	*1.50*	*Bl, Bn, T*	*3.00*	*10.00*	*10.00*	.....
3503	6.51	2.24	8.75	.....	1.67	.....	1.31	.....	2.98	.....	10.07	2.24
.....	*6.00*	*2.00*	*8.00*	*Super*	*1.50*	.....	*1.25*	*Bl, Bn, T*	*2.75*	*10.00*	*10.00*	.....
3134	14.00	0.60	14.60	.....	.....	.....	.....	.....	.....	10.17	10.17	.....
.....	*13.00*	.....	.....	*Super*	.....	.....	.....	.....	.....	*10.00*	*10.00*	.....
3469	8.35	2.40	10.75	.....	1.89	.....	2.09	.....	3.98	7.94	7.94	.....
.....	*7.00*	*3.00*	*10.00*	*Supr, Bn*	*2.00*	.....	*2.00*	*Bl, Bn, T*	*4.00*	*7.00*	*7.00*	.....
3477	8.12	3.38	11.50	.....	1.14	.....	1.96	.....	3.10	7.94	7.94	0.70
.....	*8.00*	*3.00*	*11.00*	*Supr, Bn*	*1.00*	.....	*2.00*	*Bl, Bn, T*	*3.00*	*8.00*	*8.00*	.....
3486	.....	.....	9.45	.....	2.00	.....	.....	.....	2.00	18.21	18.21	1.22
.....	.....	.....	*8.50*	*Super*	*1.90*	.....	.....	.....	*1.90*	*18.50*	*18.50*	.....
3528	**12.18**	5.32	17.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*13.50*	*1.50*	*15.00*	*Min Phos*	.....	.....	.....	.....	.....	.....	.....	.....
3537	**6.20**	7.40	13.60	.....	.....	.....	.....	.....	.....	.....	.....	.....
3539	9.32	5.78	15.10	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*10.00*	*2.00*	*12.00*	*Min Phos*	.....	.....	.....	.....	.....	.....	.....	.....
3228	.....	.....	4.40	.....	1.14	1.44	8.15	.....	10.73	.....	2.23	.....
3296	.....	.....	5.80	.....	1.49	1.30	6.59	.....	9.38	.....	2.71	.....
3344	.....	.....	3.70	.....	0.94	1.22	6.08	.....	8.24	.....	2.86	.....
3381	.....	.....	4.05	.....	1.61	12.9	7.00	.....	9.90	.....	2.78	.....
3384	.....	.....	4.40	.....	2.05	1.15	7.38	.....	10.58	.....	2.55	.....
3562	.....	.....	4.15	.....	2.27	1.45	6.58	.....	10.30	.....	1.62	.....
3569	.....	.....	4.25	.....	1.04	0.83	4.75	.....	6.62	.....	1.72	.....
3277	.....	.....	.....	.....	.....	.....	12.70	.....	12.70	.....	.....	.....
3340	.....	.....	.....	.....	.....	.....	13.58	.....	13.58	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.50*	.....	*13.50*	.....	.....	.....
3071	.....	.....	23.00	.....	.....	.....	4.03	.....	4.03	.....	.....	.....
.....	.....	.....	*21.00*	.....	.....	.....	*4.00*	.....	*4.00*	.....	.....	.....
3090	.....	.....	22.20	.....	.....	.....	4.25	.....	4.25	.....	.....	.....
.....	.....	.....	*21.00*	.....	.....	.....	*4.30*	.....	*4.30*	.....	.....	.....
3177	.....	.....	21.80	.....	.....	1.10	2.97	.....	4.07	.....	.....	.....
.....	.....	.....	*22.00*	.....	.....	.....	*4.00*	.....	*4.00*	.....	.....	.....
3208	.....	.....	23.51	.....	.....	.....	3.85	.....	3.85	.....	.....	.....
.....	.....	.....	*21.00*	.....	.....	.....	*4.00*	.....	*4.00*	.....	.....	.....
3226	.....	.....	25.30	.....	.....	.....	3.60	.....	**3.60**	.....	.....	.....
.....	.....	.....	*21.00*	.....	.....	.....	4.00	.....	*4.00*	.....	.....	.....
3278	8.04	1.56	9.60	*Super, Bn*	1.29	0.24	2.25	*Bl, Bn, Fs, G, T*	3.78	.....	2.87	1.00
3341	**6.60**	1.80	8.40		0.99	0.20	3.23		4.42	.....	2.33	1.00
.....	*8.00*	*1.00*	*9.00*		*1.00*	.....	*3.00*		*4.00*	*2.00*	*2.00*	.....
3287	7.65	1.60	9.25		1.69	0.15	4.26		6.10	3.04	3.04	.....
.....	*8.00*	*1.00*	*9.00*		*2.00*	.....	*4.00*		*6.00*	*2.00*	*2.00*	.....
3452	7.98	1.72	9.70		3.16	.....	2.75		5.91	2.46	2.46	.....
.....	*8.00*	*1.00*	*9.00*		*3.00*	.....	*3.00*		*6.00*	*2.00*	*2.00*	.....

**3177—60% fine. Contains added ammonium sulphate. *3226—42% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Pacific Guano & Fertilizer Co. *—Continued.*		
3410	Double Superphosphate	Big 3 Ranch Co., San Bernardino	45.93
	Guaranteed		*46.57*
3529	G. G.	Chas. Fellows, Modesto	22.74
	Guaranteed		*20.40*
3328	Lawn Dressing	West Coast Seed Co., Los Angeles	25.50
3549	Lawn Dressing	Stoddard Milling Co., Napa	25.37
	Guaranteed		*24.60*
3089	Nitrate of Soda	H. C. Rumohr, Redlands	42.36
	Guaranteed		*39.96*
3224	Nitrate of Soda	B. S. Casey, Rialto	41.22
3363	Nitrate of Soda	B. L. Byer, Upland	42.14
	Guaranteed		*40.50*
3091	P. N. K.	H. C. Rumohr, Redlands	26.57
	Guaranteed		*22.70*
3545	P. P.	Fair Oaks Fruit Co., Fair Oaks	20.41
	Guaranteed		*21.00*
3199	Special	Mrs. Alice Marllette, Redlands	31.42
3271	Special	H. C. Rumohr, Redlands	32.64
	Guaranteed		*31.80*
3290	Special	B. S. Casey, Rialto	33.42
	Guaranteed		*30.50*
3332	Special	West Coast Seed Co., Los Angeles	21.00
	Guaranteed		*19.96*
3517	Special	A. T. Botts, Palermo	30.20
	Guaranteed		*30.80*
3574	Special	A. L. Brooks, Loomis	26.36
	Guaranteed		*26.00*
3579	Special	Robert Baird, Porterville	33.82
	Guaranteed		*33.40*
3092	Sulfate of Potash	H. C. Rumohr, Redlands	48.80
	Guaranteed		*49.00*
3209	Sulfate of Potash	C. A. Ferguson, Colton	47.08
3223	Sulfate of Potash	B. S. Casey, Rialto	49.76
	Guaranteed		*50.00*
3298	Sulfate of Potash	H. C. Rumohr, Redlands	49.88
	Guaranteed		*49.50*
3393	Sulfate of Potash	Redlands Fruit Assn., Redlands	50.72
	Guaranteed		*50.40*
3210	Superphosphate	C. A. Ferguson, Colton	17.98
3227	Superphosphate	B. S. Casey, Rialto	17.80
3289	Superphosphate	B. S. Casey, Rialto	17.00
3526	Superphosphate	Chas. Fellows, Modesto	19.10
	Guaranteed		*17.50*
3346	Superphosphate	R. T. Nelson, Upland	17.34
	Guaranteed		*18.50*

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3410	45.93	0.12	46.05	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*46.57*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3529	12.45	2.10	14.55	.....	.....	.....	1.30	.....	1.30	.....	4.25	1.22
.....	*12.00*	*1.00*	*13.00*	*Supr. Bn*	.....	.....	*1.00*	*Bl, Bn, G*	*1.00*	.....	*4.00*	.....
3328	9.35	0.20	9.55	.....	.....	4.21	.....	.....	4.21	4.29	**4.29**	0.62
3549	9.75	0.10	9.85	.....	.....	3.95	.....	.....	3.95	4.52	4.52	0.60
.....	*8.00*	*1.00*	*9.00*	*Super*	.....	*4.00*	.....	.....	*4.00*	*5.00*	*5.00*	.....
3089	.....	.....	.....	.....	15.69	.....	.....	.....	15.69	.....	.....	.....
.....	.....	.....	.....	.....	*14.80*	.....	.....	.....	*14.80*	.....	.....	.....
3224	.....	.....	.....	.....	15.27	.....	.....	.....	15.27	.....	.....	.....
3363	.....	.....	.....	.....	15.61	.....	.....	.....	15.61	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3091	9.34	3.56	12.90	.....	.....	.....	2.21	.....	2.21	.....	6.97	1.85
.....	*7.50*	*3.00*	*10.50*	*Super, Bn, G*	.....	.....	*2.00*	*Bl, Bn, G, T*	*2.00*	.....	*6.00*	.....
3545	12.15	0.64	13.15	.....	.....	.....	.....	.....	.....	8.26	**8.26**	0.60
.....	*12.00*	*1.00*	*13.00*	*Super*	.....	.....	.....	.....	.....	*9.00*	*9.00*	.....
3199	8.04	1.36	9.40	*Super, Bn, G*	1.89	.....	3.75	*Bl, Bn, Fs, G, T*	**5.64**	2.74	2.74	.....
3271	7.99	1.26	9.25		2.07	0.20	3.94		6.21	2.24	2.24	.....
.....	*8.00*	*1.00*	*9.00*		*2.00*	.....	*4.00*		*6.00*	*2.00*	*2.00*	.....
3290	7.85	2.20	10.05		3.66	.....	3.20		6.86	2.01	2.01	.....
.....	*8.00*	*1.00*	*9.00*		*3.00*	.....	*3.00*		*6.00*	*2.00*	*2.00*	.....
3332	7.53	1.12	8.65		1.41	0.27	1.55		3.23	2.25	2.25	.....
.....	*6.00*	*2.50*	*8.50*		*1.63*	.....	*1.63*		*3.26*	*2.00*	*2.00*	.....
3517	8.46	0.44	8.90	.....	3.73	.....	1.87	.....	**5.60**	4.01	4.01	0.62
.....	*8.00*	.....	.....	*Super*	*4.00*	.....	*2.00*	*Bl*	*6.00*	*4.00*	*4.00*	.....
3574	7.75	1.10	8.85	.....	.....	.....	3.93	.....	3.93	.....	2.45	1.12
.....	*8.00*	.....	.....	*Super Bn, G*	.....	.....	*4.00*	*Bl, Bn, T*	*4.00*	*2.00*	*2.00*	.....
3579	.....	.....	10.50	.....	2.03	0.14	5.15	.....	7.32	.....	.....	.....
.....	.....	.....	*10.50*	*Super Bn, G*	*1.50*	.....	*5.50*	*Bl, Bn, T*	*7.00*	.....	.....	.....
3092	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.80	48.80	1.85
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*49.00*	*49.00*	.....
3209	.....	.....	.....	.....	.....	.....	.....	.....	.....	47.08	**47.08**	1.90
3223	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.76	49.76	1.88
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*50.00*	*50.00*	.....
3298	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.88	49.88	2.20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*49.50*	*49.50*	.....
3393	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.72	50.72	2.20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*50.40*	*50.40*	.....
3210	17.98	1.02	19.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
3227	17.80	0.70	18.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
3289	17.00	0.50	17.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
3526	19.10	0.30	19.40	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*17.00*	*1.50*	*18.50*	.....	.....	.....	.....	.....	.....	.....	.....	.....
3346	**17.34**	0.76	18.10	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	*18.50*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Pacific Guano & Fertilizer Co. —*Continued.*		
3072*	Tankage	Carlsbad Guano & Fert. Co., Redlands	31.54
	Guaranteed		*30.00*
3087*	Tankage	H. C. Rumohr, Redlands	33.37
	Guaranteed		*32.30*
3207*	Tankage	C. A. Ferguson, Colton	30.78
	Guaranteed		*30.92*
3225*	Tankage	B. S. Casey, Rialto	34.74
	Guaranteed		*33.74*
3291*	Tankage	B. S. Casey, Rialto	31.96
	Guaranteed		*30.92*
3292*	Tankage	B. S. Casey, Rialto	25.41
	Guaranteed		*26.91*
3297*	Tankage	H. C. Rumohr, Redlands	35.39
	Guaranteed		*34.99*
3301*	Tankage	H. C. Rumohr, Redlands	25.83
	Guaranteed		*25.23*
3312*	Tankage	B. L. Byer, Upland	32.10
	Guaranteed		*31.46*
3350*	Tankage	Clark Hickoe, Etiwanda	.....
3355*	Tankage	Bloomington Fruit Assn., Bloomington	.....
	Sold on Station Analysis.		
3424*	Tankage	W. A. Atkinson, Azusa	31.19
	Guaranteed		*30.95*
3434*	Tankage	C. A. Boettger, Redlands	33.38
	Guaranteed		*32.94*
3522*	Tankage	J. T. Gorden, Jr., Azusa	34.05
	Guaranteed		*33.64*
	Redlands Fertilizer Ass'n, Redlands, Cal.		
3251*	Bone Meal	Warehouse, Redlands	28.83
	Guaranteed		*28.72*
3268	Nitrate of Soda	Warehouse, Redlands	42.74
	Guaranteed		*40.50*
3062	Sulfate of Potash	Warehouse, Redlands	49.20
3316	Sulfate of Potash	Warehouse, Redlands	48.48
	Guaranteed		*48.60*
3235*	Tankage	Warehouse, Redlands	36.55
	Guaranteed		*36.59*
	Redlands Fruit Association, Redlands, Cal.		
3392*	Bone Meal	Warehouse, Redlands	30.65
	Guaranteed		*29.94*
3069	Nitrate of Soda	Warehouse, Redlands	42.39
3391	Nitrate of Soda	Warehouse, Redlands	41.90
	Guaranteed		*40.50*

*3072—75% fine. *3225—64% fine. *3297—91% fine.
*3087—82% fine. *3291—72% fine. *3301—72% fine. Some hoof.
*3207—83% fine. *3292—92% fine. *3312—73% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3072	.....	.....	17.85		.....	.....	4.91		4.91	.....	.....	
.....	.....	.....	*15.70*		.....	.....	*4.90*		*4.90*	.....	.....	
3087	.....	.....	19.20		.....	.....	5.06		5.06	.....	.....	
.....	.....	.....	*18.00*		.....	.....	*5.00*		*5.00*	.....	.....	
3207	.....	.....	10.95		.....	.....	5.87		5.87	.....	.....	
.....	.....	.....	*10.04*		.....	.....	*6.00*		*6.00*	.....	.....	
3225	.....	.....	**10.65**		.....	.....	7.22		7.22	.....	.....	
.....	.....	.....	*12.30*		.....	.....	*6.65*		*6.65*	.....	.....	
3291	.....	.....	16.15		.....	.....	5.38		5.38	.....	.....	
.....	.....	.....	*16.20*		.....	.....	*5.10*		*5.10*	.....	.....	
3292	.....	.....	10.75		.....	.....	4.45		4.45	.....	.....	
.....	.....	.....	*11.58*		.....	.....	*4.68*		*4.68*	.....	.....	
3297	.....	.....	18.00		.....	.....	5.67		5.67	.....	.....	
.....	.....	.....	*18.40*	*Bn*	.....	.....	*5.50*	*Bl, Bn*	*5.50*	.....	.....	
3301	.....	.....	15.40		.....	.....	3.92		3.92	.....	.....	
.....	.....	.....	*16.30*		.....	.....	*3.60*		*3.60*	.....	.....	
3312	.....	.....	16.25		.....	.....	5.37		5.37	.....	.....	
.....	.....	.....	*16.27*		.....	.....	*5.20*		*5.20*	.....	.....	
3350	.....	.....	10.60		.....	.....	4.90		4.90	.....	.....	
3355	.....	.....	9.50		.....	.....	6.95		6.95	.....	.....	
3424	.....	.....	10.30		.....	.....	6.18		6.18	.....	.....	
.....	.....	.....	*10.80*		.....	.....	*6.03*		*6.03*	.....	.....	
3434	.....	.....	10.05		.....	.....	6.62		6.62	.....	.....	
.....	.....	.....	*10.61*		.....	.....	*6.41*		*6.41*	.....	.....	
3522	.....	.....	13.10		.....	.....	6.22		6.22	.....	.....	
.....	.....	.....	*13.08*		.....	.....	*6.12*		*6.12*	.....	.....	
3251	.....	.....	**23.50**	.....	.....	.....	3.31	.....	3.31	.....	.....	
.....	.....	.....	*25.00*	.....	.....	.....	*3.00*	.....	*3.00*	.....	.....	
3268	.....	.....	.....	.....	15.83	.....	.....	.....	15.83	.....	.....	
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	
3062	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.20	49.20	1.12
3316	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.48	48.48	2.44
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*48.60*	*48.60*	
3235	.....	.....	9.60	.....	.....	.....	7.81	.....	7.81	.....	.....	
.....	.....	.....	*9.82*	*Bn*	.....	.....	*7.78*	*Bl, Bn*	*7.78*	.....	.....	
3392	.....	.....	**26.40**	.....	.....	.....	3.42	.....	3.42	.....	.....	
.....	.....	.....	*27.74*	.....	.....	.....	*2.96*	.....	*2.96*	.....	.....	
3069	.....	.....	.....	.....	15.70	.....	.....	.....	15.70	.....	.....	
3391	.....	.....	.....	.....	15.52	.....	.....	.....	15.52	.....	.....	
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	

*3350—89% fine.
*3355—82% fine.
*3424—76% fine.
*3434—86% fine.
*3522—88% fine.
*3251—61% fine.
Some hoof.
*3235—67% fine.
*3392—39% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Redlands Fruit Association— *Continued.*		
3269	Royal Knight	Warehouse, Redlands	26.38
3394	Royal Knight	Warehouse, Redlands	33.79
	Guaranteed		*26.45*
3070	Sulfate of Potash	Warehouse, Redlands	48.56
	Guaranteed		*45.00*
	San Bernardino Fertilizer Works, San Bernardino, Cal.		
3266	Orange and Lemon No. 1	Redlands Fertilizer Assn., Redlands	25.48
	Guaranteed		*25.40*
3060	Nitrate of Soda	Redlands Fertilizer Assn., Redlands	42.36
	Guaranteed		*40.50*
3064	Special *4–8–5–8*	Redlands Fertilizer Assn., Redlands	**23.42**
	Guaranteed		*27.60*
	So. California Fertilizer Co., Los Angeles, Cal.		
3139	*2–12–5*	R. J. Laidlow, Upland	26.43
	Guaranteed		*21.40*
2950	"A" Special	Factory, Ontario	27.90
3140	"A" Special	Factory, Ontario	26.78
	Guaranteed		*26.48*
2953	Nitrate of Soda	Factory, Ontario	42.06
	Guaranteed		*40.50*
2951	Special Mix	W. A. Freemire, Ontario	24.41
	Guaranteed		*20.00*
2952	Special Mix	Factory, Ontario	22.85
	Guaranteed		*23.10*
	Standard Rendering Co., Kansas City, Mo.		
2908*	Standard One	Corona Lemon Co., Corona	$32.15
2909*	Standard One	Corona Lemon Co., Corona	32.28
2914*	Standard One	Corona Lemon Co., Corona	32.24
2928*	Standard One	Corona Lemon Co., Corona	32.15
3249*	Standard One	Redlands Fertilizer Assn., Redlands	31.19
3330*	Standard One	Ford Ranch, Los Angeles	31.86
	Guaranteed		*30.59*
2910*	Standard One	Corona Lemon Co., Corona	32.45
3331*	Standard One	Ford Ranch, Los Angeles	31.79
3356*	Standard One	Dr. G. L. Hutchinson, Los Angeles	31.13
3402*	Standard One	A. P. Griffith, Azusa	31.94
	Guaranteed		*30.50*

*2908—85% fine.
*2909—86% fine.
*2914—85% fine.
*2928—85% fine.
*3249—84% fine.
*3330—84% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3269	7.25	2.60	9.85	.....	1.66	0.54	2.56	.....	4.76	1.86	1.86	.
3394	12.30	2.50	14.80	.....	1.99	0.32	2.84	.....	5.15	2.86	2.86	.
.....	*5.00*	*5.00*	*10.00*	*Bn,G*	*1.50*	*0.50*	*3.00*	*Bl, Bn, G, T*	*5.00*	*2.00*	*2.00*	.
3070	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.56	48.56	2.80
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*45.00*	*45.00*	.
3266	6.50	3.40	9.90	.....	1.56	0.15	1.86	.....	**3.57**	5.55	5.55	. .
.....	*5.00*	*5.00*	*10.00*	*Supr, Bn*	*2.00*	.....	*2.00*	*Bl, Bn, G*	*4.00*	*5.00*	*5.00*	.
3060	.....	.....	.....	.....	15.69	.....	.....	.....	15.69	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3064	6.05	2.60	8.65	.....	2.59	.....	1.17	.....	3.76	4.66	**4.66**	.....
.....	*5.00*	*3.00*	*8.00*	*Super Bn, G*	*2.00*	.....	*2.00*	*Bl, Bn, G*	*4.00*	*8.00*	*8.00*	.
3139	13.00	0.30	13.30	.....	0.30	0.27	1.46	.....	2.03	5.90	5.90	.....
.....	.....	.....	*12.00*	*Super Bat. G*	.....	.....	*2.00*	*Bat G, Sheep, G*	*2.00*	*5.00*	*5.00*	.....
2950	10.43	2.72	13.15	.....	1.75	0.41	1.90	.....	4.06	2.93	2.93	.....
3140	8.49	2.16	10.65	.....	1.81	0.29	2.25	.....	4.35	2.74	2.74	0.65
.....	*8.00*	.....	.....	*Super Bn, G*	.....	.....	*4.12*	*Bn, G*	*4.12*	*2.00*	*2.00*	.....
2953	.....	.....	.....	.....	15.58	.....	.....	.....	15.58	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
2951	12.04	2.46	14.50	.....	0.50	0.27	1.70	.....	2.47	2.50	2.50	.....
.....	*10.00*	.....	.....	*Bn, G*	.....	.....	*2.00*	*Bn, G*	*2.00*	*2.00*	*2.00*	.....
2952	.....	.....	6.55	.....	1.08	0.72	2.81	.....	4.61	2.10	2.10	.....
.....	.....	.....	*3.00*	*Super Bn. G*	.....	.....	*4.75*	*Bn, G, T*	*4.75*	*2.00*	*2.00*	.....
2908	.....	.....	21.50	*Bn*	.....	.....	4.32	*Bl, Bn*	4.32	.....	.....	.....
2909	.....	.....	21.90		.....	.....	4.28		4.28	.....	.....	.....
2914	.....	.....	21.90		.....	.....	4.27		4.27	.....	.....	.....
2928	.....	.....	21.50		.....	.....	4.32		4.32	.....	.....	.....
3249	.....	.....	21.15		.....	.....	4.14		**4.14**	.....	.....	.....
3330	.....	.....	20.80		.....	.....	4.37		4.37	.....	.....	.....
.....	.....	.....	*18.25*		.....	.....	*4.50*		*4.50*	.....	.....	.....
2910	.....	.....	22.95		.....	.....	4.16		**4.16**	.....	.....	.....
3331	.....	.....	22.00		.....	.....	4.16		**4.16**	.....	.....	.....
3356	.....	.....	21.50		.....	.....	4.08		**4.08**	.....	.....	.....
3402	.....	.....	22.50		.....	.....	4.11		**4.11**	.....	.....	.....
.....	.....	.....	*18.25*		.....	.....	*4.50*		*4.50*	.....	.....	.....

*2910—83% fine.
*3331—83% fine.
*3356—83% fine.
*3402—83% fine.

ANALYSES AND VALUATIONS.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Standard Rendering Co.— *Continued.*		
2915*	Standard One	Corona Lemon Co., Corona	31.16
	Guaranteed		*30.14*
2943*	Standard One	Corona Lemon Co., Corona	32.44
3599*	Standard One	Corona Lemon Co., Corona	32.34
3606*	Standard One	Corona Lemon Co., Corona	32.02
3610*	Standard One	Corona Lemon Co., Corona	33.08
	Guaranteed		*30.41*
3473*	Standard One	Gifford & Morgan, Lindsay	32.06
	Guaranteed		*30.68*
3075*	Standard Two	W. B. Burr, Los Angeles	32.68
	Guaranteed		*30.03*
	Swift & Co., Chicago, Ill.		
3063*	*3–12–6*	Redlands Fertilizer Assn., Redlands	26.41
	Guaranteed		*26.40*
3267	*4–12–3*	Redlands Fertilizer Assn., Redlands	27.56
	Guaranteed		*27.40*
3044	Blood	P. E. Stanton, Covina	57.41
3045	Blood	P. E. Stanton, Covina	57.24
3076	Blood	E. L. Koethen, Riverside	57.37
	Guaranteed		*55.65*
3047*	Diamond C	P. E. Stanton, Covina	27.80
	Guaranteed		*26.80*
3283*	Diamond C	G. W. Duley, Upland	28.85
	Guaranteed		*26.75*
2933*	Diamond E	G. W. Duley, Upland	31.42
	Guaranteed		*31.45*
3056*	Diamond E	P. E. Stanton, Covina	30.04
	Guaranteed		*31.55*
3057*	Diamond E	P. E. Stanton, Covina	34.68
	Guaranteed		*31.65*
3265*	Diamond E	Redlands Fertilizer Assn., Redlands	32.68
	Guaranteed		*32.25*
3282*	Diamond E	G. W. Duley, Upland	31.91
3566*	Diamond E	E. L. Koethen, Riverside	32.34
	Guaranteed		*31.85*
3315*	Diamond E	Redlands Fertilizer Assn., Redlands	32.57
	Guaranteed		*31.75*
3285	Diamond K	G. W. Duley, Upland	29.70
	Guaranteed		*29.40*
3279	Diamond L	G. W. Duley, Upland	30.94
3280	Diamond L	G. W. Duley, Upland	32.39
3281*	Diamond L	G. W. Duley, Upland	28.55
	Guaranteed		*30.20*
3409	Diamond N	G. W. Duley, Upland	37.57
	Guaranteed		*36.75*

*2915—82% fine.
*2943—80% fine.
*3599—80% fine.
*3606—80% fine.
*3610—80% fine.
*3473—86% fine.
*3075—80% fine.
*3063—Derivations not guaranteed.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
2915	.....	.....	20.70		.....	.....	4.32		4.32	.....	.....	.....
.....	.....	.....	*18.25*		.....	.....	*4.50*		*4.50*			
2943	.....	.....	19.70		.....	.....	4.76		4.76	.....	.....	.....
3599	.....	.....	21.95		.....	.....	4.33		4.33			
2606	.....	.....	21.10		.....	.....	4.40		4.40	.....	.....	.....
3610	.....	.....	21.50		.....	.....	4.60		4.60	.....	.....	.....
.....	.....	.....	*18.25*	*Bn*	.....	.....	*4.50*	*Bl, Bn*	*4.50*	.....		
3473	.....	.....	20.50		.....	.....	4.45		4.45	.....	.....	.....
.....	.....	.....	*18.25*		.....	.....	*4.50*		*4.50*			
3075	.....	.....	18.40		.....	.....	5.05		5.05	.....	.....	.....
.....	.....	.....	*13.50*		.....	.....	*5.25*		*5.25*			
3063	.....	.....	11.55	.....	.....	.....	2.82	.....	2.82	7.04	7.04	.....
.....	.....	.....	*12.00*	.....	.....	.....	*3.00*	.....	*3.00*	*6.00*	*6.00*	
3267	.....	.....	12.25	.....	.....	.....	3.94	.....	3.94	3.23	3.23	.....
.....	.....	.....	*12.00*	*Bn*	.....	.....	*4.00*	*Bl, Bn*	*4.00*	*3.00*	*3.00*	.....
3044	.....	.....	.....	.....	.....	.....	13.67	.....	13.67	.....	.....	.....
3045	.....	.....	.....	.....	.....	.....	13.63	.....	13.63	.....	.....	.....
3076	.....	.....	.....	.....	.....	.....	13.66	.....	13.66	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	*13.25*	.....	*13.25*	.....	.....	.....
3047	.....	.....	25.10	.....	.....	.....	2.75	.....	2.75	.....	.....	.....
.....	.....	.....	*25.00*	*Bn*	.....	.....	*2.50*	*Bn*	*2.50*	.....	.....	.....
3283	.....	.....	28.30	.....	.....	.....	2.23	.....	2.23	.....	.....	.....
.....	.....	.....	*25.00*	*Bn*	.....	.....	*2.50*	*Bn*	*2.50*	.....	.....	.....
2933	.....	.....	16.80		.....	.....	5.12		5.12	.....	.....	.....
.....	.....	.....	*17.50*		.....	.....	*5.00*		*5.00*			
3056	.....	.....	18.60		.....	.....	4.41		**4.41**	.....	.....	.....
.....	.....	.....	*17.50*		.....	.....	*5.00*		*5.00*			
3057	.....	.....	**16.20**		.....	.....	5.77		5.77	.....	.....	.....
.....	.....	.....	*17.50*		.....	.....	*5.00*		*5.00*	.....	.....	.....
3265	.....	.....	16.80		.....	.....	5.23		5.23	.....	.....	.....
.....	.....	.....	*17.50*		.....	.....	*5.00*		*5.00*			
3282	.....	.....	18.60		.....	.....	4.82		4.82	.....	.....	.....
3566	.....	.....	20.00		.....	.....	4.68		**4.68**	.....	.....	.....
.....	.....	.....	*17.50*	*Bn*	.....	.....	*5.00*	*Bl, Bn*	*5.00*			
3315	.....	.....	18.40		.....	.....	5.05		5.05	.....	.....	.....
.....	.....	.....	*17.50*		.....	.....	*5.00*		*5.00*			
3285	.....	.....	24.30		.....	.....	2.31		2.31	3.45	**3.45**	.....
.....	.....	.....	*22.00*		.....	.....	*2.50*		*2.50*	*4.00*	*4.00*	.....
3279	.....	.....	16.05		.....	.....	3.75		3.75	4.71	4.71	0.62
3280	.....	.....	15.00		.....	.....	4.23		4.23	4.97	4.97	.....
3281	.....	.....	26.80		.....	.....	1.73		**1.73**	2.87	**2.87**	.....
.....	.....	.....	*16.00*		.....	.....	*3.75*		*3.75*	*4.00*	*4.00*	.....
3409	.....	.....	14.50		.....	.....	5.78		5.78	3.90	3.90	.....
.....	.....	.....	*12.50*		.....	.....	*6.00*		*6.00*	*4.00*	*4.00*	

*3047—57% fine.
*3283—56% fine.
*2933—71% fine.
*3056—73% fine.
*3057—75% fine.
*3265—88% fine.
*3282—79% fine.
*3566—79% fine.
*3315—77% fine.
*3281—These goods are doubtless incorrectly tagged.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Swift & Co.—Continued.		
3284*	Special Bone Meal	G. W. Duley, Upland	25.24
	Guaranteed		*23.43*
3046*	Tankage	P. E. Stanton, Covina	39.63
	Guaranteed		*37.31*
3077*	Tankage	E. L. Koethen, Riverside	38.77
3565*	Tankage	S. L. Herrick, Riverside	40.86
	Guaranteed		*38.24*
3234*	Tankage	Redlands Fertilizer Assn., Redlands	38.87
	Guaranteed		*38.96*
	Union Fertilizer Co., Los Angeles, Cal.		
2966	Fruiting	Cyrus Baldwin, Corona	21.98
3033	Fruiting	W. F. Tyler, Upland	22.63
3105	Fruiting	W. C. McCully, Corona	22.42
3201	Fruiting	S. L. Main, Colton	22.29
3215	Fruiting	J. F. Jackson, Riverside	22.17
3295	Fruiting	H. C. Lash, Rialto	21.73
3448	Fruiting	Chas. H. Low, Riverside	22.25
3449	Fruiting	Arlington Heights Fruit Co., Riverside	20.99
3458	Fruiting	David B. Wolf, Glendora	21.94
3460	Fruiting	Arlington Heights Fruit Co., Riverside	20.73
3558	Fruiting	Chas. H. Low, Riverside	20.87
3559	Fruiting	Arlington Heights Fruit Co., Riverside	20.66
3572	Fruiting	Arlington Heights Fruit Co., Riverside	21.32
	Guaranteed		*20.90*
3065	Fruiting and Potash	Steward Citrus Assn., Upland	23.19
	Guaranteed		*23.16*
2992	Mills Special	Arlington Heights Fruit Co., Riverside	23.19
2993	Mills Special	Arlington Heights Fruit Co., Riverside	22.70
2999	Mills Special	Arlington Heights Fruit Co., Riverside	21.88
3014	Mills Special	Arlington Heights Fruit Co., Riverside	21.92
3037	Mills Special	Arlington Heights Fruit Co., Riverside	22.31
3042	Mills Special	Arlington Heights Fruit Co., Riverside	22.35
3078	Mills Special	Arlington Heights Fruit Co., Riverside	23.03
3079	Mills Special	Arlington Heights Fruit Co., Riverside	23.04
3088	Mills Special	Arlington Heights Fruit Co., Riverside	22.63
3093	Mills Special	Rrlington Heights Fruit Co,. Riverside	23.02
3094	Mills Special	Arlington Heights Fruit Co., Riverside	23.13
	Guaranteed		*21.90*
3371	Nitrate of Soda	Highgrove Fruit Exchange, Highgrove	42.28
	Guaranteed		*40.50*
3032	Nursery	W. F. Tyler, Upland	$25.89
3138	Nursery	H. W. White, Glendora	25.29
3141	Nursery	C. H. Tyler, Pomona	25.92
3153	Nursery	E. E. Cole, Redlands	25.97
3413	Nursery	Geo. H. Dole, Riverside	26.28
3432	Nursery	L. S. Taylor, San Dimas	25.83
	Guaranteed		*25.60*

3284—67% fine.

*3046—62% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	Phosphoric Acid				Nitrogen					Potash		Chlorin
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3284	.....	.....	29.30	....	.. ....	... .	1.24	.....	1.24			
.....	.....	.....	*29.00*	....	.....	... .	*0.82*	.....	*0.82*			
3046	.....	.....	5.65		.....	.....	9.49		9.49	.....	.....	.....
.....	.....	.....	*5.00*		.....	.....	*9.00*		*9.00*	. .....	. .	..
3077	.....	.....	5.65		.....	.....	8.98		8.98	.....	.	.
3565	.....	.....	7.20	*Bn*	.....	.....	9.28	*Bl. Bn*	9.28	. .	... .	.
.....	.....	.....	*5.00*		.....	.....	*9.00*		*9.00*	. .	.	.
3234	.....	.....	8.20		.....	.....	8.41		**8.41**	..	. .	
.....	.....	.....	*5.00*		.. ....	.....	*9.00*		*9.00*	..	. .	.
2966	7.03	2.42	9.45		1.38	0.62	1.26		3.26	3.49	3.49	0.68
3033	6.81	3.19	10.00		1.56	0.76	1.14		3.46	3.64	3.64	.....
3105	6.94	2.06	9.00		1.46	0.60	1.39		3.45	3.46	3.46	0.65
3201	6.70	1.90	8.60		1.70	0.54	1.42		3.66	3.05	3.05	.....
3215	7.59	1.26	8.85		1.04	0.82	1.32		3.18	3.69	3.69	0.75
3295	7.26	1.44	8.70		0.97	0.75	1.41		3.13	3.53	3.53	0.70
3448	7.28	1.32	8.60		1.74	0.50	1.30		3.54	3.14	3.14	0.95
3449	7.59	0.96	8.55		1.71	0.50	1.06		3.27	2.76	2.76	0.85
3458	7.69	1.06	8.75		1.61	0.48	1.28		3.37	3.03	3.03	.....
3460	6.75	1.50	8.25		1.61	0.44	1.16		3.21	3.16	3.16	0.80
3558	7.00	1.40	8.40		1.62	0.45	1.08		3.15	3.36	3.36	0.75
3559	7.40	1.20	8.60		1.83	0.40	0.88		3.11	3.20	3.20	0.75
3572	7.48	0.92	8.40		1.72	0.42	1.11		3.25	3.21	3.21	0.75
.....	*7.00*	*1.50*	*8.50*	*Super, Bn, G*	*0.75*	*0.60*	*1.65*	*Bn, G, T*	*3.00*	*3.00*	*3.00*	.....
3065	6.16	1.84	8.00		1.29	0.59	1.35		3.23	5.76	5.76	0.75
.....	*7.00*	*1.50*	*8.50*		*0.75*	*0.60*	*1.65*		*3.00*	*5.25*	*5.25*	.....
2992	7.03	1.62	8.65		1.14	0.60	1.56		3.30	4.51	4.51	0.65
2993	6.72	1.58	8.30		1.51	0.58	1.34		3.43	4.30	4.30	0.65
2999	6.50	1.70	8.20		1.39	0.57	1.30		3.26	4.15	4.15	0.60
3014	6.83	1.82	8.65		1.23	0.60	1.32		3.15	4.08	4.08	.....
3037	6.30	2.40	8.70		1.53	0.62	1.16		3.31	4.54	4.54	0.62
3042	6.39	2.36	8.75		1.58	0.63	1.15		3.36	4.40	4.40	0.65
3078	7.19	2.06	9.25		1.40	0.61	1.24		3.25	4.57	4.57	0.62
3079	6.61	2.34	8.95		1.41	0.64	1.33		3.38	4.58	4.58	0.57
3088	7.20	1.90	9.10		1.39	0.62	1.29		3.30	4.02	4.02	0.62
3093	7.10	1.70	8.80		1.49	0.61	1.24		3.34	4.55	4.55	0.70
3094	7.40	1.40	8.80		1.45	0.62	1.27		3.34	4.44	4.44	0.68
.....	*7.00*	*1.50*	*8.50*		*0.75*	*0.60*	*1.65*		*3.00*	*4.00*	*4.00*	.....
3371	.....	.....	.....	.....	15.66	.....	.....	.....	15.66	.....	.....	.....
.....	.....	.....	.....	.....	*15.00*	.....	.....	.....	*15.00*	.....	.....	.....
3032	6.09	1.86	7.95		2.99	0.56	1.69		5.24	2.66	2.66	0.60
3118	6.64	1.86	8.50		2.80	0.56	1.56		4.92	2.45	2.45	0.65
3141	6.01	1.74	7.75		3.14	0.51	1.69		5.34	2.56	2.56	.....
3153	5.90	2.05	7.95		3.84	0.22	1.52		5.58	2.19	2.19	.....
3413	7.12	1.28	8.40		1.99	0.90	1.93		4.82	3.04	3.04	0.65
3432	6.20	1.30	7.50		2.25	0.89	2.10		5.24	2.15	2.15	.....
.....	*6.00*	*1.50*	*7.50*	*Super, Bn, G*	*1.00*	*1.00*	*3.00*	*Bn, G, T*	*5.00*	*1.50*	*1.50*	.....

*3077—73% fine. *3565—74% fine. *3234—79% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Union Fertilizer Co.— *Continued.*		
3194	Special	A. T. Hansen, Pasadena	22.78
	Guaranteed		*21.50*
3293*	Special	H. C. Lash, Rialto	19.82
	Guaranteed		*19.90*
2967	Special Fruiting	W. A. Hively, Corona	25.69
3154	Special Fruiting	E. E. Cole, Redlands	26.53
3294	Special Fruiting	H. C. Lash, Rialto	27.08
	Guaranteed		*25.90*
3031*	Tankage	W. F. Tyler, Upland	31.46
	Guaranteed		*30.81*
3155*	Tankage	E. E. Cole, Redlands	30.66
	Guaranteed		*29.84*
3156*	Tankage	E. E. Cole Redlands	32.62
	Guaranteed		*33.56*
3171*	Tankage	Thos. Strain, Jr., Fullerton	**27.47**
	Guaranteed		*31.22*
	Union Superphosphate Co., San Francisco, Cal.		
3096	Superphosphate	S. W. McColloch, Fullerton	18.22
	Guaranteed		*17.80*
3109	Superphosphate	Chula Vista L. G. Assn., Chula Vista	18.30
	Guaranteed		*17.64*
3238	Superphosphate	P. J. Bollinger, Riverside	17.55
	Guaranteed		*17.90*
3437	Superphosphate	S. W. McColloch, Fullerton	17.64
	Guaranteed		*18.05*
3438	Superphosphate	S. W. McColloch, Fullerton	17.50
	Guaranteed		*18.10*
3521	Superphosphate	Highland O. G. Assn., Highland	18.06
	Guaranteed		*17.28*
	Western Meat Company, San Francisco, Cal.		
3551	Diamond A	Sebastopol Berry Growers, Sebastopol	21.58
	Guaranteed		*22.16*
3250*	Diamond I	Redlands Fertilizer Assn., Redlands	31.05
	Guaranteed		*30.70*

*3293—Goods incorrectly branded as "Special." Derivations incorrectly stated.

*3031—84% fine.

*3155—64% fine.

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3194	5.80	1.20	7.00		1.96	0.74	1.63		4.33	2.62	2.62	0.7
.....	*5.50*	.....	.....	*Super, Bn, G*	*1.00*	*1.00*	*2.00*	*Bn, G, T*	*4.00*	*2.50*	*2.50*	
3293	.....	.....	22.80		0.14	0.20	0.73		1.07	.....	.....	
.....	.....	.....	*21.00*		.....	.....	*1.30*		*1.30*	.....	.....	
2967	**6.95**	2.30	9.25		2.23	0.85	1.34		4.42	3.97	3.97	0.6
3154	**6.65**	2.60	9.25		2.35	0.85	1.40		4.60	4.52	4.52	
3294	7.60	1.90	9.50		2.75	0.22	1.67		4.64	4.00	4.00	0.6
.....	*8.00*	*1.50*	*9.50*		*1.00*	*0.75*	*2.25*		*4.00*	*3.50*	*3.50*	
3031	.....	.....	13.60		.....	.....	5.54		5.54	.....	.....	
.....	.....	.....	*13.75*		.....	.....	*5.35*		*5.35*	.....	.....	
3155	.....	.....	14.65		.....	.....	5.40		5.40	.....	.....	
.....	.....	.....	*13.75*	*Bn*	.....	.....	*5.35*	*Bl, Bn*	*5.35*	.....	.....	
3156	.....	.....	14.65		.....	.....	5.65		**5.65**	.....	.....	
.....	.....	.....	*14.00*		.....	.....	*6.00*		*6.00*	.....	.....	
3171	.....	.....	**16.70**		.....	.....	4.13		**4.13**	.....	.....	
.....	.....	.....	*19.50*		.....	.....	*4.60*		*4.60*	.....	.....	
3096	18.22	0.48	18.70	.....	.....	.....	.....	.....	.....	.....	.....	
.....	*17.80*	*0.40*	*18.20*	.....	.....	.....	.....	.....	.....	.....	.....	
3109	18.30	0.70	19.00	.....	.....	.....	.....	.....	.....	.....	.....	
.....	*17.64*	*0.36*	*18.00*	.....	.....	.....	.....	.....	.....	.....	.....	
3238	17.55	0.75	18.30	.....	.....	.....	.....	.....	.....	.....	.....	
.....	*17.90*	*0.30*	*18.20*	.....	.....	.....	.....	.....	.....	.....	.....	
3437	17.64	0.46	18.10	.....	.....	.....	.....	.....	.....	.....	.....	
.....	*18.05*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
3438	17.50	0.50	18.00	.....	.....	.....	.....	.....	.....	.....	.....	
.....	*18.10*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
3521	18.06	0.44	18.50	.....	.....	.....	.....	.....	.....	.....	.....	
.....	*17.28*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
3551	12.45	1.20	13.65	.....	.....	.....	1.46	.....	1.46	.....	2.81	1.00
.....	*12.00*	*1.50*	*13.50*	*Supr, Bn*	.....	.....	*1.64*	*Bl, Bn*	*1.64*	*3.00*	*3.00*	
3250	.....	.....	13.40	.....	.....	.....	5.50	.....	5.50	.....	.....	
.....	.....	.....	*13.75*	*Bn*	.....	.....	*5.35*	*Bl, Bn*	*5.35*	.....	.....	

*3156—84% fine.
*3171—69% fine.
*3250—83% fine.

ANALYSES AND VALUATIONS—Continued.

Laboratory Number.	Name and Address of Manufacturer or Dealer, and Name of Brand.	From Whom Obtained.	Value per Ton at Station Prices.
	Woodbridge Fertilizer Co., Los Angeles, Cal.		
3082	*2–8–5*	Factory, Los Angeles	16.51
	Guaranteed		*16.00*
3081	*2–8–6*	Factory, Los Angeles	23.14
	Guaranteed		*19.60*
3059	Lawn	Factory, Los Angeles	**16.97**
	Guaranteed		*20.00*
3537	Special	Wm. R. Staats Co., Pasadena	18.36
	Guaranteed		*18.40*
3231	Sulfate of Potash	Sparr Fruit Co., Los Angeles	50.92
	Guaranteed		*48.60*
3173	Sulfate of Potash	V. Peyton, Los Angeles	51.36
	Guaranteed		*49.21*
3243	Superphosphate	E. D. Roberts, San Bernardino	17.80
	Guaranteed		*17.98*

ANALYSES AND VALUATIONS—Continued.

POUNDS PER HUNDRED.

Laboratory Number.	PHOSPHORIC ACID				NITROGEN					POTASH		CHLORIN
	Available.	Insoluble.	Total.	Guaranteed as derived from.	In Nitrates.	In Ammonia Salts.	Organic.	Organic Nitrogen guaranteed as derived from.	Total.	From Sulfate.	Total.	
3082	.....	.....	8.10	.....	2.03	.....	.....	.....	2.03	5.36	5.36	..
.....	.....	.....	*8.00*	*Supr, Bn*	*2.00*	.....	.....	.....	*2.00*	*5.00*	*5.00*	...
3081	.....	.....	7.45	.....	.....	.....	2.87	.....	2.87	6.45	6.45	0.7
.....	.....	.....	*8.00*	*Supr, Bn*	.....	.....	*2.00*	*Bl, Bn*	*2.00*	*6.00*	*6.00*	
3059	.....	.....	9.10	.....	1.91	.....	0.19	.....	**2.10**	4.68	4.68	..
.....	.....	.....	*10.00*	*Supr, Bn*	.....	.....	.....	.....	*2.50*	*3.00*	*3.00*	
3537	7.53	0.72	8.25	.....	1.96	.....	0.14	.....	2.10	5.54	5.54	0.7
.....	.....	.....	*8.00*	*Super*	*2.10*	.....	.....	.....	*2.10*	*5.00*	*5.00*	.
3231	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.92	50.92	1.7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*48.60*	*48.60*	...
3173	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.36	51.36	1.7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*49.21*	*49.21*	. ..
3243	17.80	0.70	18.50	.....	.....	.....	.....	.....	.....	.....	.....	..
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TOLERANCE OF EUCALYPTUS FOR ALKALI

WITH PARTIAL REPRINT FROM BULLETIN 196

By R. H. LOUGHRIDGE

BULLETIN No. 225

(Berkeley, Cal., October, 1911)

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1911

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TOLERANCE OF EUCALYPTUS FOR ALKALI.

By R. H. Loughridge.

During the past few years the interest in Eucalyptus growing has been widespread over the State, because of the increasing scarcity of timber trees for commercial purposes, the prospect of "splendid financial returns" to growers after the lapse of fifteen or more years and because of the special adaptation of California climate and soil to that group of trees.

It goes without saying that for all plants and trees the better the soil the better the growth, and Eucalyptus is not an exception. It attains its most rapid growth in a loose loam soil that contains an abundance of the plant food elements, potash, lime, magnesia, iron, phosphoric acid, and especially of humus with high nitrogen content; a soil of ten or more feet in depth in which root development and activity may be free and unrestricted by hardpan, bedrock, gravel, or high water-table; a soil having a good moisture supply and good aeration; a soil that is warm and capable of facilitating bacterial activity in the formation of nitrates from the organic nitrogen of humus. But lands of this nature are usually far more valuable for other cultural purposes than the growth of Eucalyptus trees, and for this reason the culture of the latter on the large scale is often being done or attempted on tracts that seem to be unfitted for general farming purposes.

It thus happened that attention was called to the large tracts of alkali land, that occur in those portions of the valleys of the State where a low rainfall and other conditions have favored the accumulation of these soluble alkali salts. It is well known that plants both small and large can withstand the effect of only certain amounts of these salts, and that they also vary in their power of tolerance, some being very sensitive and others quite immune except to very large amounts. Citrus trees, for instance, seem to be seriously affected by 2,500 pounds of common salt per acre, while grapes grow fairly well in many times that amount.

Recognizing this fact the eucalyptus grower quickly appealed to this station for information as to the amount of alkali the eucalyptus would tolerate while making good growth. It has unfortunately happened that while we have for the past fifteen years made observations regarding very many other cultures, such as grain crops, alfalfa, fruit trees, etc., only casual attention has been given to the Eucalyptus; in fact, the only analysis of alkali in a soil growing these trees which we were

able to find was that from the Tulare Station; and a search of publications from other states and countries gave no record of such an examination, the various writers on the planting and growing of eucalypts having failed to note the alkali side of the question. Even at the Tulare Station, where quite a number of large Eucalyptus trees are growing, no examination was considered important until the question of tolerance came from growers.

We then took up the task of trying to ascertain as near as possible the alkali tolerance of the chief species of the tree, working thereto in several directions; first to ascertain the maximum amount in which the trees were growing and doing well, and the minimum amount of each salt where they had succumbed to the effects of the alkali alone; second, to examine new plantations and nurseries in which the alkali was plainly present; and third, to select a large alkali spot in which to plant several of the more important species in alkali of varying strengths.

Mr. Frank E. Johnson, assistant in the soil laboratory, was intrusted with the work of visiting the plantations of eucalypts in the alkali regions of the State, noting tree conditions and collecting soils for examination. He also made the greater number of alkali analyses that are given in this report.

The identification of species from samples brought in was largely done by Prof. H. M. Hall, botanist of this station; unfortunately, it was impossible to recognize the species of many of the specimens, and the results of the examinations of soils in which these were growing were thus of no practical value and are omitted from this report.

The work, however, upon which we relied chiefly in our study of the alkali tolerance of the eucalypts was with seedlings planted in the Tulare Station, and this was carried on under the supervision of the foreman, J. T. Bearss.

CONDITIONS TO BE MET IN THESE INVESTIGATIONS.

The investigation of the tolerance of alkali on the part of any culture is a matter of great difficulty because of the impossibility of eliminating the many causes other than alkali that might produce injury, disease and death, such as insects, shallowness and bad physical conditions in the soil, improper water supply, climatic troubles, etc. All of these must be considered when studying the question, and they make the effort to arrive at correct, or even approximately correct conclusions, especially difficult. To these must be added the irregular and broad extension of the root systems, and the irregular distribution in the soil, both downward and laterally, of the alkali salts and of each individual salt; these could in large measure be controlled or eliminated by planting in a large number of boxes of proper sizes in which certain percentages of alkali salts are thoroughly intermixed with the soil, the roots held

in contact with the alkali, and water conditions kept in control, but even this would be attended with uncertainties and would have to be extended over several seasons, before conclusions could be definitely reached.

In the field examinations, therefore, we have found it unsafe to claim that a tree or plant has been injured or killed by the amount of alkali in its soil (except of course the amount be enormous), unless corroborated by a number of instances where soil conditions are perfect. We can only ascertain the *highest amount* of each particular alkali salt or combination of salts occurring in the upper few feet of the soil in which the plant or tree is apparantly unharmed, thus fixing for the time being its maximum of tolerance; this maximum may subsequently be raised by other observations. If other individuals of the same species are suffering or injured in soils containing less amounts of the salts than the supposed maximum, then we must attribute the injury to other causes than alkali alone.

A very large number of examinations are therefore necessary to ascertain this maximum because of the uncertainty of the strength of alkali in each locality. Thus, in this Eucalyptus investigation, we have made several hundred analyses to ascertain the amount and composition of the alkali salts under as many trees.

If alkali consisted of but one salt the study of toleration would be quite simple; but we find that there are several salts, each having a different effect and behavior, which tend to complicate the study with reference to plants and trees. These salts are sulfate of soda or glaubers salt, carbonate of soda or sal soda and chlorid of sodium or common salt, together with more or less of sulfates of magnesia and lime and nitrates of soda and magnesia. The three first named are however recognized as *the alkali salts,* and are alone considered when alkali is mentioned.

Difference in Action of Alkali Salts.—Each salt has its influence on plant growth, but in different degrees of intensity and in nature of action; and this of course still further complicates the study of tolerance on the part of the plant. The sulfates seem to be rather inert for any direct injury; being very soluble in water, they probably enter the plant cells with solutions of plant food, and if in very large amounts interfere with the proper assimilation and action of the food; or by accumulation as a soil crust they may interfere with the functions of the plant roots.

Common salt is with some cultures probably the most to be feared of the three alkali salts, not so much, perhaps, because of any direct action on the plant, but because of its injurious influence on important microorganisms in the soil, its action through a greater depth than the carbonate, its action when in larger amounts in preventing a normal water supply and consequent starvation of the plant, and in the fact that the

injury can only be prevented by its removal from the soil by thorough leaching.

The carbonate of soda is strongly caustic or corrosive, attacking the root-hairs and the tender bark of the root crown, girdling it and preventing the rise of sap into the plant. It, therefore, acts most energetically near the surface of the soil, and, fortunately, may be here easily neutralized by conversion into sulfate on the application of gypsum, as long ago recommended in the publications of this station.

These salts occur together in greatly varying proportions through the soil column downward and laterally because of differences in the ease with which they move from point to point; the sulfates because of their crystalline form rise rapidly in the soil and with the chlorids occur chiefly in the upper foot; while the carbonate occurs more generally diffused downward. The effect on the plant is therefore largely influenced by the amount of each salt in the soil and their relative proportion; thus forming a problem the more complex as the effects of the salts depend largely upon the physical nature of the soil.

Irregular Distribution of Alkali.—The irregular distribution of the alkali as a whole and of each salt throughout the soil was an especial disturbing element in this investigation. Not only is this the case in a vertical column of four or more feet, but we find the same irregular distribution in a horizontal section. This is shown in the analyses of samples from the cross-section of an alkali plot in the Tulare Station made a number of years ago by C. A. Colmore, and reported in the report of this station for 1902:

PERCENTAGE COMPOSITION OF SALTS IN AN ALKALI SPOT.

Depth.	32 feet from center.				16 feet from center.				Center of spot.			
	Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.
First foot	.74	.01	.14	.89	1.02	.01	.17	1.20	1.09	.01	.01	1.11
Second foot	.05	.03	.01	.09	.36	.01	.03	.40	.23	.02	.01	.26
Third foot	.03	.01	------	.04	.05	.01	.01	.07	.14	.01	.01	.16
Fourth foot	.02	.01	------	.03	.05	.01	------	.06	.08	.01	------	.09
Average	.21	.02	.04	.27	.37	.01	.05	.43	.39	.01	.01	.41

These tables are more valuable in illustrating the irregular downward distribution than the horizontal, for the holes were dug at distances of sixteen feet from each other. On other pages of this bulletin will be found a table and diagram on which are shown the percentages of alkali found at distances of but a few feet in all directions, and which very forcibly illustrates this rapidly changing composition. In fact,

we believe that columns of alkali soils but a few inches apart would show the same variability in amount and composition of its alkali.

In this table there is laterally more of total salts and of chlorids and somewhat less of carbonates and sulfates at 16 feet from the center than in the center, while at 32 feet there is a falling off in total salts, sulfates, and chlorids, but an increase in the carbonates.

In the vertical columns the alkali is concentrated in the first foot, but the carbonate has its highest percentages in the second foot.

It is chiefly this irregular distribution of each salt that makes difficult the task of arriving at definite conclusions on the toleration of any plant, and shows the importance of taking the soil samples in close proximity to the plant or tree.

Alkali Exists in small instead of very large Areas.—Another condition to interfere with the investigation is the fact that alkali occurs only in spots and of varying strengths. These spots are often but a few feet in diameter; hence trees near together may be growing under entirely different alkali conditions and the amount tolerated by one tree may not be the same that occurs beneath the others.

This condition is shown in the small tract of young trees planted on the Tulare Station. It is this condition that makes it inadvisable to present the alkali percentages on a map, for small spots or areas are usually far apart with larger intermediate tracts of land that may be nearly or quite free from alkali. Of course in some sections of the State, especially in the trough connecting the lakes that lie in the upper part of the San Joaquin Valley, the alkali is quite continuous, but even then in varying amounts from one hundred thousand pounds per acre in six feet to so low an amount as to insure crop productiveness.

To this fact combined with the irregular distribution of the salts in amounts and kinds is due the great difficulty in selecting proper soil samples.

Movement of Alkali in the Soil.—Another factor to be regarded in the problem of tolerance is the movement or rise and fall of alkali salts at different seasons of the year due to water evaporation. In the alkali regions of California there are really but two seasons, the *winter or wet season,* from November to April, during which time the entire yearly precipitation occurs, and the *summer or dry season,* when there is practically no rainfall. The salts of alkali being extremely soluble in water, therefore, are dissolved in winter rain and pass downward with the water to depths dependent on the physical condition of the soil and the amount of rain, but usually three or four feet.

During this wet period of course the roots near the soil surface are relieved of the influence of the alkali and may attain good development before the hot rainless summers produce an upward capillary movement

of the water and alkali, and a concentration of the latter in the upper foot or two, where damage is done to the roots.

All of these conditions must be considered when we study the plant, together with the annual or seasonal rainfall as indicating to what depth the water may percolate and carry the salts with them. A precipitation of an inch of rain will penetrate 4 or 5 inches in a loam soil and less in a clay soil. A continuous fall of 5 inches of rain would therefore wash the alkali down through a depth of probably 18 or 20 inches. Should this be followed by a warm, protracted dry spell the alkali water would doubtless rise by capillarity to be again carried down by subsequent rains. This rise and fall of the alkali salts produces a critical period in the life and growth of the young trees with their root systems limited in length and spread, and subject to attack by the alkali and more especially by the caustic carbonate. Could the alkali be kept down for some feet in the soil until the young roots become strong, well developed and with a comparatively thick bark the tree may survive alkali of quite a strength. There is but little doubt that many eucalypti now growing in strong alkali soils, have been enabled to secure good, strong root-development during the time that the alkali was several feet below the surface and thus to become partly if not wholly immune to its effect when subsequently concentrated near the surface. When the tender roots reach below the zone of alkali the tree is quite safe from injury. This point of view is emphasized by the native mesquit which we find growing in the strongest of alkali lands, its thick and deep-lying roots being well protected against the influence of alkali by thick, tough bark.

This uncertainty regarding the movement of the several salts, and this irregularity of alkali composition and distribution, was one of the chief sources of trouble in studying the effect on trees and plants, for not until an analysis has been made of the alkali content of the soil can we judge of its strength and percentage composition.

Development of the Eucalyptus Root System.—In addition to the climatic and other difficulties to be met in the study of the influence of the alkali salts upon the life and growth of the eucalypts we have that of the rapid development of the root systems of the tree; this practically limits the time for observation to the earliest stages of growth when the young roots are within the alkali zone.

The Eucalyptus tree develops its root system very rapidly as it grows from the young plant to the large tree. It is a general supposition in California that the tap root reaches, if unimpeded, to a depth below the surface of the soil equal to the height of the tree above ground; this in old trees would be fully 100 feet in alluvial lands. Depths of 60 feet have been reported from southern California. The lateral extension of the roots is well known to be very great, a root one fourth of an inch

thick having been observed by us in an orchard near Riverside, at a distance of 75 feet from the tree and evidently its extension was fully 25 feet further. This large lateral development of the Eucalyptus roots, where the trees have been planted as wind breaks or for ornament, is a well known source of danger to adjacent fruit orchards because of their great absoption of soil moisture; in some cases deep trenches have been dug to cut the Eucalyptus roots and protect the orchard trees.

The Eucalyptus Timber Corporation of Tulare County has made observations of the root development of young trees and some of the results as contained in a pamphlet of the company are here given:

Age of tree.	Height of tree.	Depth of tap root.
15½ months	13 feet 6 inches	16 feet 6 inches
6 months	7 feet	7 feet 11 inches
6 months	6 feet 11 inches	8 feet
6 months	8 feet	8 feet 1 inch

The downward development is even greater in the above young trees than they are usually credited with; and if the same ratio of increase is maintained a tree 100 feet high would have a tap root from 110 to 123 feet below the surface of the ground. This is not to be greatly doubted where depth of soil strata permits, for this deep penetration of the roots of other trees, both ornamental and orchard, as well as of plants and grasses in California soils is of common observation, as reported in previous publications of this Station. The roots of wheat, barley, and the California poppy (*Eschscholtzia californica*) have been followed to depths of thirteen feet in the loam soil of the University Farm at Davis, Yolo County, California.

TEST PLOT FOR EUCALYPTUS SEEDLINGS: TULARE STATION.

The critical period in the life of any plant that has been placed in a soil is when it is very young and when its root system is very delicate and susceptible to injury, and is limited in its development to the surface foot of the soil. When to the ordinary dangers of improper temperature and moisture, poor aeration, severe soil texture and deficiency in plant food, is added that of the effect of alkali, and especially of carbonate of soda, the life of the plant is still more endangered because of the action of these salts on the extremely tender root-hairs and bark of the young roots. As the plant grows older the roots become more woody near the soil surface and are less susceptible to injury, and they also extend to greater depths and with a greatly enlarged and broadened root system; the delicate tips or newest growing parts of the roots are thus farther and farther from the influence of the alkali which usually exists only in the upper four feet. If, then, the young plant can survive the first year or two in an alkali soil there is but little doubt of its ultimate success.

An old tree growing in an alkali spot is a proof either that the alkali contained in the soil around its base was not sufficient to injure the roots when the tree was very young, or that the alkali had been kept below the roots by some system of irrigation or cultivation until their broad expansion and growth downward had carried them out of danger; for it is usually the alkali in the upper foot or two of soil that causes injury. In this report we have therefore laid greater stress on the experiments with Eucalyptus seedlings planted in a spot of alkali soil in the Tulare Station than upon observations upon older trees.

Distribution of Alkali in Soil of Eucalyptus Plot.—A spot of supposedly very strong alkali was chosen near the southwest corner of the Tulare Station tract on which to test the effect of alkali of different strengths upon young eucalypts of the different species chiefly grown in this State. In previous years eucalypts had been planted here, and some of these still remain around the spot, but many had died from various causes. This spot embraced an irregular area of about 150 by 100 feet, and in its center the soil was covered with a coating of alkali salts and was entirely bare of vegetation. A preliminary determination of the strength and distribution of the alkali was made by the analyses of nearly one hundred four-foot soil-columns taken at distances of ten feet in each direction. The results in percentages are given in the accompanying table; and also in the diagram, in which is also presented many subsequent analyses which were made of soils taken very close to the young trees that had been planted. The diagram is shaded to show

at a glance the varying intensities of total salts; the large numbers represent approximately the number of pounds of alkali per acre in a depth of four feet in each shaded area.

ALKALI SALTS IN THE SOILS OF THE EUCALYPTUS TEST PLOT, TULARE STATION.

Taken four feet in depth at distances of ten feet in each direction.

Sulfates	.048	.070	.110	.192	.257	.395	.114	.157	.130	.065	.072
Carbonates	.007	.007	.007	.007	.014	.005	.005	.005	.005	.006	.005
Chlorids	.028	.009	.005	.005	.019	.074	.005	.028	.019	.023	.009
Totals	.083	.084	.122	.204	.290	.474	.124	.190	.154	.094	.086
Sulfates	.058	.076	.048	.174	.290	.257	.425	.193	.104	.137	.094
Carbonates	.005	.003	.007	.009	.009	.012	.002	.010	.009	.005	.007
Chlorids	.005	.009	.009	.009	.005	.009	.009	.005	.005	.009	.009
Totals	.068	.088	.164	.252	.304	.278	.436	.208	.118	.151	.110
Sulfates	.078	.088	.170	.397	.347	.375	.281	.279	.140	.141	.138
Carbonates	.007	.003	.007	.002	.005	.004	.009	.005	.007	.005	.005
Chlorids	.005	.005	.009	.005	.009	.009	.014	.019	.019	.028	.009
Totals	.090	.096	.186	.404	.361	.388	.304	.303	.166	.174	.152
Sulfates	.111	.130	.227	.482	.411	.520	.305	.234	.168	.118	.114
Carbonates	.002	.005	.007	.007	.009	.003	.012	.009	.009	.005	.005
Chlorids	.009	.009	.009	.023	.009	.009	.028	.023	.019	.009	.005
Totals	.122	.144	.243	.512	.414	.532	.345	.266	.196	.132	.124
Sulfates	.110	.116	.191	.226	.460	.330	.331	.184	.164		
Carbonates	.003	.007	.010	.009	.009	.009	.005	.005	.003	Trees	
Chlorids	.009	.005	.005	.009	.009	.009	.019	.009	.009		
Totals	.122	.128	.206	.244	.478	.348	.355	.198	.176		
Sulfates	.168	.184	.148	.152	.222	.318	.187	.193	.165		
Carbonates	.003	.005	.009	.010	.011	.012	.008	.002	.002	Trees	
Chlorids	.009	.009	.009	.009	.009	.009	.009	.009	.009		
Totals	.170	.198	.166	.171	.232	.339	.204	.204	.176		
Sulfates	.103	.123	.167	.182	.186	.119	.116	.111			
Carbonates	.004	.003	.004	.005	.004	.004	.005	.002		Trees	
Chlorids	.005	.009	.009	.005	.009	.009	.009	.009			
Totals	.112	.135	.180	.192	.199	.132	.130	.122			
Sulfates	.195	.090	.110	.107	.116	.122					
Carbonates	.003	.004	.005	.006	.005	.005	Large trees				
Chlorids	.009	.009	.009	.009	.009	.009					
Totals	.208	.104	.124	.122	.130	.136					
Sulfates	.168	.227	.116	.122		.163					
Carbonates	.009	.009	.006	.005		.002	Large trees				
Chlorids	.009	.009	.014	.028		.009					
Totals	.186	.245	.136	.155		.174					

A spot of maximum intensity is seen near the center of the plot where the percentage is .63 as an average of the four-foot column of soil, but thence in all directions the percentage is less and the alkali diminishes with great irregularity out to the edges of the tract. The outlines of each area of intensity are also peculiarly curved.

The table and the diagram illustrate very forcibly the following facts,

often brought out with emphasis in this and former publications of this station:

1. That the distribution of alkali and of its salts in any plot is very irregular.

2. That great differences both in quality and in amount exist at distances of but a few feet or even less.

3. That a plant may live and grow in one part of an alkali spot and yet be killed by stronger alkali if planted but a few feet distant.

4. That an analysis giving the composition of the soil at one point of an alkali spot may fail utterly to represent the amount of alkali of other

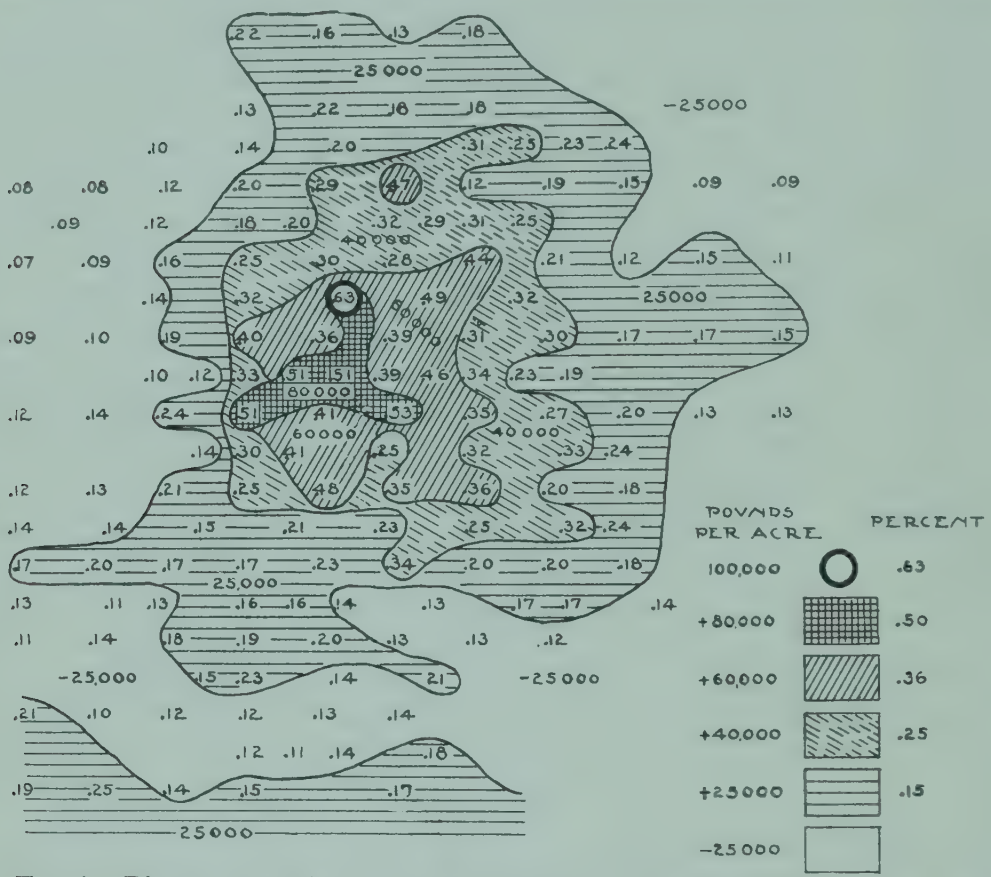

FIG. 1.—Diagram showing the distribution and intensity of alkali in the Eucalyptus plot; Tulare Station.

portions, and can not therefore be relied on when the question of treatment or crop production is to be considered.

5. That it is a grave mistake to outline large regions on a map as having each a definite percentage of alkali, for such regions mostly contain large tracts of land practically free from alkali which might thus be popularly regarded as unsuitable for crop production.

6. That the examination of an alkali spot downward is important in order to ascertain whether the alkali extends to great depths as in some parts of California, or to not more than three or four feet as is usually the case.

The area of strong alkali being limited it was determined to make plantings of but few of the more important varieties grown in this State, and we chose the *crebra, corynocalyx, cornuta, globulus, rudis, rostrata,* and *tereticornis,* small seedlings of which were obtained from the Fancher Creek nurseries at Fresno. These were planted by the foreman of the Tulare Station at distances of six feet in rows which were ten feet apart, and received two irrigations during the season. These were not planted in the rows from which soils had been taken for the original examination, but between them, and it therefore became necessary to take other samples of soil very close to the seedlings to ascertain true alkali conditions around the roots at the end of the season when the effect of the alkali was to be noted.

It was not thought necessary to examine the soil of each and all of the seedlings, and only typical ones of each of the species were analyzed, the results being given in the special discussion.

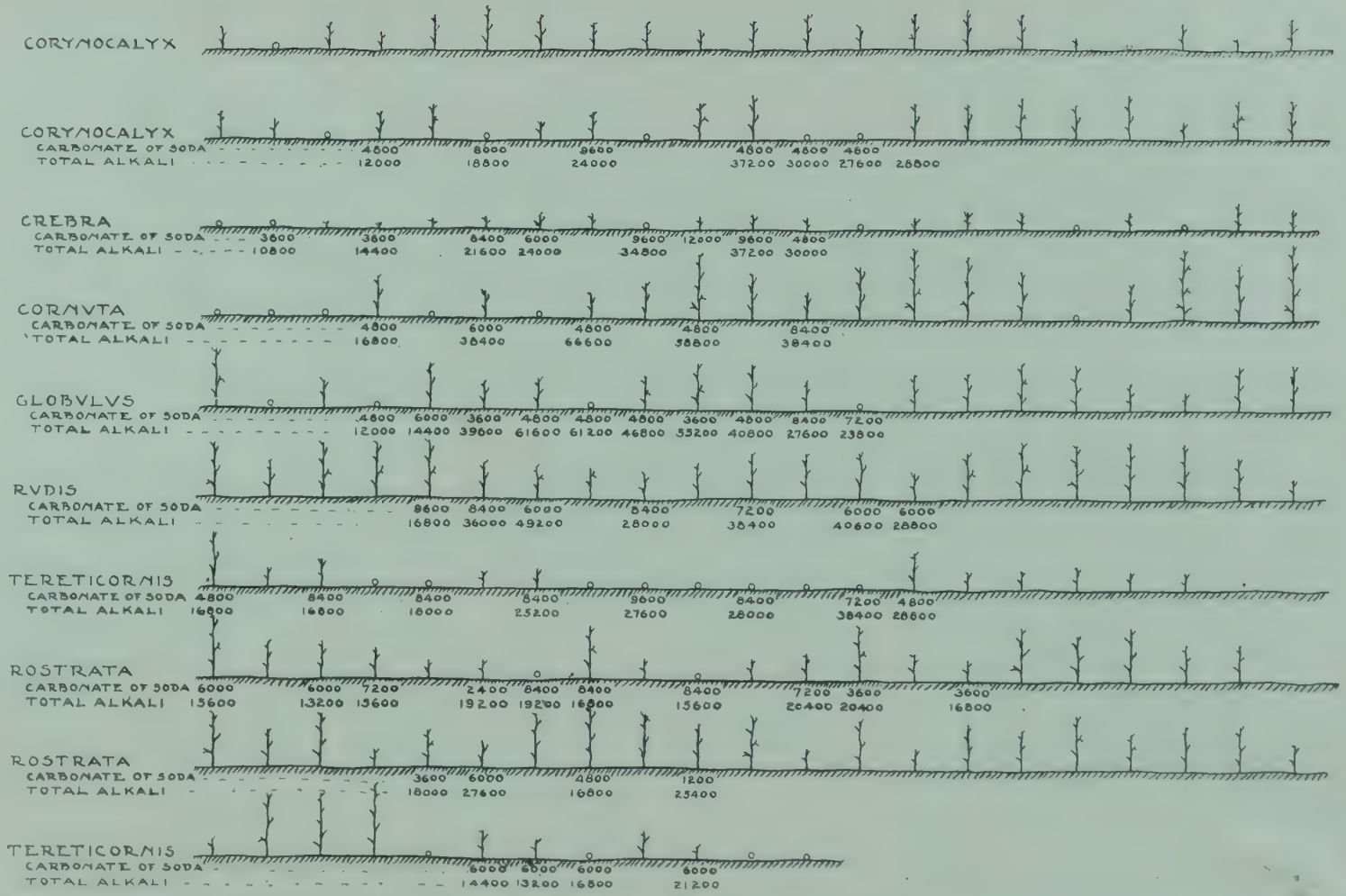

FIG. 2.—Diagram showing relative heights of seedlings and amounts of alkali near certain plants in the test plot, at the end of the first season; Tulare Station.

EFFECT OF ALKALI SALTS UPON VARIOUS SPECIES OF EUCALYPTS.

At the end of the first season, the condition and height of each plant in each species was ascertained and from these a chart (No. 2) prepared showing the relative heights; the amount of carbonate of soda and that of total alkali, given in pounds per acre in a depth of three feet very near certain seedlings, is also shown on the chart, the sulfates and chlorids being omitted as they do not seem to have produced any injurious effects.

The total number of seedlings planted was 244, and thirty-nine of these or about sixteen per cent died, presumably from the effects of alkali. A close examination, however, showed that the greater number were dwarfed or otherwise injured in comparatively small percentages of alkali salts, and that the injury was due doubtless to a combination of hurtful conditions rather than to alkali alone. The result emphasizes the importance of either eliminating from the soil all of such conditions or of not attempting to grow good trees on such poor land. The following table presents a general statement of the number of seedlings of each species that during the first season reached heights of 48 inches, from 36 to 48, from 24 to 36, from 12 to 24, and less than 12 inches and the number that died:

	Number planted.	Number within different heights.					Dead.	
		48 inches.	36-48.	24-36.	12-24.	1-12.	Number.	Per cent.
E. cornuta	27	2	5	10	3		7	25.9
E. corynocalyx	54	2	3	22	19	1	7	11.0
E. crebra	25				8	11	6	24.0
E. globulus	28			15	8	1	4	14.3
E. rostrata	54	2	10	17	22		3	5.6
E. rudis	25		8	12	5			
E. tereticornis	31	1	2	2	12	2	12	38.7

Eucalyptus tereticornis suffered more than other species, 38.7 per cent of its seedlings having died though planted in a soil containing less alkali than some of the others; the rudis suffered least of all, none of its seedlings having died. The *rostrata* lost but 5.6 per cent of its large number of seedlings.

In the following pages we give the results of the investigations thus far obtained, the amount of alkali salts under the respective trees or plants and a discussion of each of the several species tested, and we have endeavored to draw from the mass of figures some conclusions as to the tolerance of alkali salts on the part of the Eucalyptus.

EFFECT OF ALKALI SALTS UPON EUCALYPTUS CORYNOCALYX.

Investigations with *Eucalyptus corynocalyx* were chiefly made in the special alkali plot of the Tulare Experiment Station, where 54 seedlings were planted in two rows at distances of six feet, the rows being ten feet apart. Some of the trees were in strong alkali but the greater number, at either end of the rows, were planted in soils containing comparatively small amounts of the salts.

The maximum height reached by the seedlings in the first year was only 30 inches, in a soil with but little alkali and also in one containing .31 per cent of salts. Seven of the trees died, several of them from other causes than alkali; one reached a height of only 8 inches, nineteen from 12 to 24 inches, and twenty-five above that height, two of the latter being 48 inches.

In other parts of the State Mr. Johnson found but two trees that could be identified as *corynocalyx;* one near Hanford was growing in a soil that had only saltgrass on it before being brought into cultivation. It was three years old, 25 feet high, and looked thrifty though there was some yellowing of the leaves. The tree from near Fresno was two years old and 3 feet tall, and had had good care, though showing considerable effect of the alkali. It stood in a small tract where grapevines had failed to grow. The tips of its branches and leaves were reddish, and the tree rather stunted; hardpan underlaid the surface at about 4 feet.

E. CORYNOCALYX IN ALKALI SOIL.

Tree No.	Height, inches	Age, years	Condition.	Percentage in soil.				Pounds per acre in 3 feet.			
				Sulfates.	Carbonates.	Chlorids.	Total.	Sulfate of soda.	Carbonate of soda.	Chlorid of sodium.	Total salts.
			Tulare Station, 3 foot depth.								
11	30	----	Two lowest leaves red; others good	.25	.04	.02	.31	30,000	4,800	2,400	37,200
14	24	----	Two lowest leaves red; others good	.17	.04	.03	.24	20,400	4,800	3,600	28,800
4	18	----	Leaves of lower half spotted and dying	.05	.04	.01	.10	6,000	4,800	1,200	12,000
8	18	----	Lower leaves affected	.11	.08	.01	.20	13,200	9,600	1,200	24,000
6	6	----	Dead	.08	.05	.01	.14	9,600	8,000	1,200	18,800
12	8	----	Dead	.20	.04	.01	.25	24,000	4,800	1,200	30,000
13	8	----	Dead	.17	.04	.02	.23	20,400	4,800	2,400	27,600
	Ft.		*Other Localities, 4 feet deep.*								
---	25	3	Hanford, some yellow leaves	.08	.07	.01	.16	12,800	11,200	1,600	25,600
---	3	2	Fresno, stunted	.05	.02	.01	.08	8,000	3,200	1,600	12,800

A glance at the table will show that the sulfates have had but little to do with the injury to the young trees, as the greatest height reached was in a soil with the maximum of .25 per cent of sulfates (30,000 pounds) in three feet depth per acre.

The results with the young seedlings at Tulare were not at all satisfactory, for they attained their greatest height in the highest amount of sulfates and of common salt and in the same amount of carbonate of soda that occurs in the soil in which the seedling died. The *corynocalyx* will clearly withstand the effects of as much as .04 per cent of either common salt or carbonate, the equivalent of 4,800 pounds per acre in 3 feet, and is dwarfed by a larger amount if allowed to remain around the roots. It grew only 18 inches high the first year in presence of .08 per cent of carbonate of soda; this is equivalent to about 9,600 pounds per acre in three feet depth. The lower leaves showed the effect of the alkali. Much depends upon the distribution of the several salts in the soil column, for in this case an examination showed that the carbonate of soda and the sulfates were confined chiefly to the third foot, while the common salt was in largest amount in the upper two feet.

The older trees in other localities, as shown in the table, have yielded some interesting results from the examination of their soils. The samples of soil were taken to depths of four feet, and we find that the two-year-old tree at Fresno with a height of three feet was stunted in presence of only .02 per cent of carbonate of soda in the four feet, or an equivalent of but 3,200 pounds per acre, while a three-year-old tree at Hanford was 25 feet high in presence of .07 per cent of carbonate of soda. The conclusion is plain, that the young *corynocalyx* will not withstand a large amount of carbonate of soda unless the alkali be kept away from the tender roots by thorough irrigation methods; and that after it gets a good start and the roots are developed downward, the amount of carbonate of soda may be quite large without detriment to the tree.

Observations in 1910.—After the station was abandoned no attention was given to the trees, and a visit to the plot showed that ten more of the *corynocalyx* had died, six were still barely living while nineteen others (chiefly at the ends of the rows where the alkali was less) had increased in height. The greatest increase in growth was 28 inches at the extreme eastern end, and 18 inches on the west. Tree No. 4 in a soil with .04 per cent of carbonate of soda had grown 12 inches, while Nos. 11 and 14, with the same amount of carbonate, had died.

EFFECT OF ALKALI ON EUCALYPTUS CREBRA.

Eucalyptus crebra seems to be one of the slowest-growing of the Eucalyptus species, for in the Tulare Station plot, where 25 seedlings about 2 inches high were planted, the maximum height reached the first year in good soil and under favorable conditions was but 18 inches. Six of the seedlings died quickly, three made no additional growth

though keeping alive, four reached a height of six inches, four a height of 6 to 12 inches while but five grew from 12 to 18 inches high. The young seedlings are evidently very sensitive to the effects of alkali salts, for throughout nearly the entire row the leaves and the plants themselves were either dead, dying or dwarfed.

Trees Nos. 2 and 4, growing in two feet of sand overlying a clay which was full of young rootlets were but two inches high though green; No. 6 appeared healthy, had no dead leaves but was only 6 inches high; No. 7 was growing in a better soil, but its lower leaves were dead, and others becoming reddish. No. 9, two inches in height was entirely dead; No. 11 with alkali salts upon the surface of the soil around it grew 10 inches high, but the alkali had killed the lower leaves. No. 10, also surrounded by black alkali, was dying, both leaves and tips of limbs being affected; No. 12, 6 inches high was living but the leaves and tips of limbs were dying back.

These seedlings just described were selected as probably giving best results and their soil was taken to depths of three feet for alkali examination. The results are given below.

E. CREBRA IN ALKALI SOIL.

Tree No.	Height, inches.	Condition.	Percentage in soil.				Pounds per acre, 3 feet.			
			Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total alkali.
2	2	Healthy, but no growth	.05	.03	.01	.09	6,000	3,600	1,200	10,800
4	2	Healthy, but no growth	.04	.03	.05	.12	4,800	3,600	6,000	14,400
6	6	Healthy, little growth	.05	.07	.06	.18	6,000	8,400	7,200	21,600
12	6	Leaves curling	.19	.04	.02	.25	22,800	4,800	2,400	30,000
11	10	Lower leaves dead	.22	.08	.01	.31	26,400	9,600	1,200	37,200
7	4	Dying, lower leaves dead	.14	.05	.01	.20	16,800	6,000	1,200	24,000
10	6	Dying, lower leaves dead	.18	.10	.01	.29	21,600	12,000	1,200	34,800
9	2	Dead	.15	.08	.09	.32	18,000	9,600	7,200	34,800

Eucalyptus crebra clearly can not withstand a large amount of alkali if we are to judge from the above observations; for the young seedlings began to die in presence of .20 per cent of combined salts (equivalent to 24,000 pounds per acre in a depth of three feet) even when the carbonate of soda was less than where the tree was healthy. The greatest percentage of carbonate of soda in the soil of a healthy seedling was .07, corresponding to about 8,400 pounds per acre in three feet; this was combined with an equal amount of common salt.

In a row of eucalypts planted many years ago just outside of the south fence of the station tract there is a *crebra* having a height of 75 feet, which appears very healthy though growing in .11 per cent of alkali in four feet depth, which is equivalent to about 17,600 pounds per

acre; there is present only .02 per cent of carbonate of soda (3,200 pounds per acre) and the same amount of common salt. This is nearly the same amount of carbonate of soda and total salts that were found with the healthy seedlings having only two inches growth; evidently the failure of the latter to grow was due to other causes than alkali, or conditions were more favorable for the large tree when it was young.

Observations in 1910.—A year after the above observations and the abandonment of the station, further observations on the *crebra* showed that eleven more of the trees had died, chiefly in the region of strong alkali that was covered by a dense growth of alkali weed. Only three trees had shown any increased growth, one of which, No. 6, which was in .07 per cent of carbonate of soda, had grown but 6 inches in the past year. Others that had less of the carbonate had died.

The *crebra* is certainly not suited to alkali conditions.

EFFECT OF ALKALI ON EUCALYPTUS CORNUTA.

Cornuta was one of the species of eucalypts chosen for the Tulare Station plot and 27 young seedlings were set out early in the year and given the same irrigation and attention received by other species. In a good soil the growth was as great during the first year as made by any other species in this plot, the height reached being 48 inches, but only two of the trees reached this. Five other trees grew from 36 to 48 inches, ten from 24 to 36 inches, and three from 18 to 24 inches; seven of the trees had died either soon after planting or after reaching a foot or more in height.

The soils of only six of the trees that were apparently affected by alkali salts were taken for examination. Tree No. 2 had been planted in a sandy soil with hardpan at two feet and was evidently killed by lack of moisture, as the amount of alkali was very small. No. 4 was green but the tips of the leaves were beginning to turn yellow; its soil was sandy to two feet depth and underlaid by a clayey soil. No. 6 had grown to a height of two feet in a soil having hardpan at four feet, but had finally succumbed to the alkali. No. 8 in a soil similar to that of No. 4 was more severely affected by the alkali, some of the leaves beginning to die. No. 10 in a soil with .5 per cent of alkali salts and with a moist clayey subsoil at three feet showed signs of injury as some of the leaves were dying; and No. 12 in a soil similar to that of No. 10 but with less total salts and more carbonate of soda also showed the effect of the latter by the dying of the lower leaves.

The results of the examination are given in the following table:

E. CORNUTA IN ALKALI SOIL.

Tree No.	Height, Inches.	Condition.	Percentage in soil.				Pounds per acre, 3 feet.			
			Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.
10	42	A few leaves dying	.43	.04	.02	.49	51,600	4,800	2,400	58,800
4	24	Tips of leaves changing	.09	.04	.01	.14	10,800	4,800	1,200	16,800
12	20	Lower leaves dying	.24	.07	.01	.32	28,800	8,400	1,200	38,400
8	18	Leaves dying	.53	.04	.06	.63	60,600	4,800	1,200	66,600
6	24	Dead	.26	.05	.01	.32	31,200	6,000	1,200	38,400

From this table it would appear that the *cornuta* is quite sensitive to the presence of alkali salts in its soil, if the amount be as much or more than .5 per cent of total salts.

It reached its maximum height of 48 inches in .15 per cent of alkali, and 42 inches in as much as .49 per cent, but in the latter the leaves had begun to die, evidently from the effect of the alkali. The carbonate of soda seems to be controlling cause of injury to the trees for there was but .01 per cent (1,200 pounds per acre 3 feet depth) where the tree was not affected and .04 per cent where the leaves were dying though the tree was 42 inches high. In another spot a tree had grown 45 inches without apparent injury in presence of .17 per cent of total alkali and .01 per cent of carbonate of soda.

We would then place the limits of tolerance on the part of *cornuta* at about .5 per cent of total alkali salts, provided there was not more than .03 per cent of carbonate of soda present.

Observations in 1910.—A visit to the Tulare Station after its abandonment showed that all of the twenty *cornuta* trees were dead along the row through the dense patch of weeds to the east end, where a few trees had survived and had made additional growth of a foot or more in weak alkali soil. The trees were killed by the alkali and the alkali weeds.

The *cornuta* is evidently not an alkali-resistant eucalypt.

EFFECT OF ALKALI ON EUCALYPTUS GLOBULUS.

There were only twenty-eight seedlings of *Eucalyptus globulus* put in a row across the alkali plot of the Tulare Station, a few being in that part which contained 40,000 to 60,000 pounds (.35 to .50 per cent) of the salts in a depth of 3 feet per acre. The irregular distribution of the salts is well shown in diagram No. 1; No. 5 having a total of .12 per cent, while No. 6, six feet distant, has .35 per cent, and No. 7 at a distance of six feet from No. 6 has more than .50 per cent of alkali in three feet depth.

The greatest height attained in one season after planting was 34 inches, by two of the seedlings, in a soil having but little alkali. Six of the seedlings grew to 30 inches; seven 24 inches; six to 18 inches, while the others fell below this height, four dying completely. A few were selected for alkali examination, the samples of soil being taken to three feet in depth.

The seedlings were set out in the spring and it is more than likely that at that time the surface soil was quite free from alkali because of the winter and spring rains, thus enabling the roots to secure a foothold before the subsequent rise of alkali to the roots. In the fall, at the time the soil samples were taken for examination, a detailed analysis showed that the alkali was concentrated in the upper two feet where the young seedling roots were held subject to its influence. It was also found that while the sulfates and the common salt were each chiefly in the upper two feet, the carbonate of soda, on the contrary, was mainly held in the first foot. The results of analysis are shown in the following table:

E. GLOBULUS IN ALKALI SOIL.

Tree No.	Height, inches	Condition.	Percentage in soil.				Pounds per acre, 3 feet.			
			Sulfates	Carbonates	Chlorids	Total	Sulfates	Carbonates	Chlorids	Total
10	30	Leaves touched	.41	.03	.02	.46	49,200	3,600	2,400	55,200
11	30	Leaves touched	.29	.04	.01	.34	34,800	4,800	1,200	40,800
12	18	Leaves dying	.14	.07	.02	.23	16,800	8,400	2,400	27,600
6	18	Leaves dying	.29	.03	.01	.33	34,800	3,600	1,200	39,600
7	18	Dead	.46	.04	.01	.51	55,200	4,800	1,200	61,200
5	18	Leaves turning	.06	.05	.01	.12	7,200	6,000	1,200	14,400
9	12	Leaves dying	.33	.04	.02	.39	39,600	4,800	2,400	46,800
4	3	Dead	.05	.04	.01	.10	6,000	4,800	1,200	12,000
8	10	Dead	.46	.04	.01	.51	55,200	4,800	1,200	61,200
13	8	Dead	.12	.06	.01	.19	14,400	7,200	1,200	23,800

A study of the alkali figures and the condition of the trees point plainly to the fact that it is a mistake to base the tolerance of alkali by a plant alone upon the total amount present in a certain depth of soil, but that the amounts of individual salts must be taken into account. Thus, we find the tree growing to its maximum height of 30 inches in a spot where there was .46 per cent of total alkali (55,200 pounds per acre in 3 feet), while it was dwarfed in much smaller amounts because of the presence of more carbonate of soda in the upper two feet. In another spot the growth was but 18 inches in presence of .51 per cent of alkali, but the tree had died, and probably the slow growth as well as the death of the seedling was due to the larger amount of carbonate of soda as well as of the total alkali.

That the sulfate of soda has but little injurious effect on any plant, except in very large amounts, has been shown in other publications of

this station, and is here well illustrated in tree No. 10 which grew to a height of 30 inches in the presence of .41 per cent of sulfates, or the equivalent of about 50,000 pounds per acre in a depth of 3 feet.

The carbonate of soda was the most hurtful of the alkali salts, and the seedlings seem to show in their leaves that they feel the effect of .04 per cent, though the plant No. 11 reached its maximum growth of 30 inches in a soil containing that percentage. Where the percentage of carbonate of soda was more than .04 the seedlings were either dwarfed in growth or dead. It seems, then, that the limit of tolerance of the *E. globulus* for carbonate of soda may be placed at .04 per cent or its equivalent of about 5,000 pounds per acre in a depth of three feet.

The tree is not as susceptible to common salt as to carbonate of soda, and the amounts found in the row of trees are hardly worthy of consideration, the highest amount being but .02 per cent, or 2,400 pounds in 3 feet depth per acre, and in this it reached nearly its greatest growth.

It is evident that other causes than alkali alone have caused the death or dwarfing of many of the seedlings. In fact, Nos. 4 and 13, which were killed, and No. 5, which was dwarfed, were in soils holding less total salts, as well as less of each salt than No. 12 which grew to a height of 18 inches.

Observations in 1910.—Observations made a year later on the condition of the young *globulus* at the station showed that every young tree from Nos. 4 to 20, had died either from lack of water, from the effect of alkali, or because of the dense mass of alkali weed that had been allowed to grow after the station was abandoned. All of the plants, the analyses of whose soils are given in the tables, were dead and only outside of the weed patch and almost wholly on the east, where there was but little alkali, had the trees made additional growth, the maximum increase being about four feet.

Young E. globulus at Buena Park, Orange County.—Buena Park is located in the region of alluvial lands that lie south of Los Angeles. In this is a young grove of *E. globulus* on the east side of the railroad, two miles north of Buena Park, which was planted three years before this examination was made. A large alkali spot occurs in the grove, and though planted and treated as the rest, the young trees within its area were killed by the excessive alkali which covers the ground in summer with a white crust. The alkali spot is irregular in outline and along its border are trees that have been more or less dwarfed by the alkali and seemed to afford good examples for study.

The accompanying photographs show the conditions prevailing in this field; Fig. 3 is a view of the thick crust of alkali salts, cut into by the wheel of the vehicle. The soil had been thrown up into ridges for irrigation and the planting of the eucalypts; the tops of the ridges show thicker alkali than in the swales where it is weaker and permits of the

growth of alkali weeds. The trees that were planted all died, except along the border, as shown in the photo, and there those in front were lower in height than those in the rear though of the same age, evidently the effect of the stronger alkali. The other photograph is a nearer view of the tall trees with smaller ones on the right, which in turn give way to only alkali weeds and grass and finally to only alkali salts, as shown in the other photograph. Soils Nos. 1, 2 and 9 are from the locality shown in Fig. 4, while the others are from along the border of the trees shown in Fig. 3.

Certain of the young trees were chosen that were seemingly affected differently by different amounts of the alkali and samples of their soil were taken within a few inches of the tree, and to a depth of 4 feet, and submitted to chemical analysis. The results are shown in the following table:

E. GLOBULUS IN ALKALI SOIL NEAR BUENA PARK, LOS ANGELES COUNTY.

Soil No.	Height, feet	Condition.	Percentage in soil.				Pounds per acre, 4 feet.			
			Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.
1	22	4½ inches in diameter	.21	.02	.03	.26	33,600	3,200	4,800	41,600
2	10	1⅜ inches in diameter	.11	.04	.01	.16	17,600	6,400	1,600	25,600
3	10	1¾ inches in diameter	.17	.02	.03	.22	27,200	3,200	4,800	35,200
4	3	Healthy	.18	.02	.05	.25	28,800	3,200	8,000	40,000
5	6	Lower branches dead	.22	.06	.04	.32	35,200	9,600	6,400	51,200
6	7	Dying	.33	.05	.10	.48	52,800	8,000	16,000	76,800
7	8	Dead	.36	.02	.12	.50	57,600	3,200	19,200	80,000
8	----	Salt grass only	.19	.05	.05	.29	30,400	8,000	8,000	46,400
9	----	Salt grass and weeds	.27	.09	.03	.39	43,200	14,400	4,800	62,400
10	----	Salt grass only	.49	.02	.12	.73	78,400	3,200	19,200	100,800
11	----	Nothing growing	.53	.12	.14	.84	92,800	19,200	22,400	134,400

In this grove we found a tree, No. 1, 22 feet in height growing where there was no indication of alkali, as the ground around it was covered with grass, and yet the examination showed the presence of .26 per cent (nearly 42,000 pounds per acre) of total salts in 4 feet depth. The tree was in splendid condition, full foliage and with a trunk having a diameter of four and one half inches. There was but .02 per cent of carbonate of soda in the soil. A tree, No. 2, near this, having a height of but ten feet, though of the same age, had twice the amount of carbonate of soda, .04 per cent (6,400 pounds per acre) in four feet depth. The tree was healthy and had a diameter of one and three fourths inches. The diminished growth is probably due to the larger amount of carbonate of soda, for in a soil having a still greater amount, .06 per cent (9,600 pounds per acre), a tree, No. 5, was growing with a height of but six feet and some of the lower branches were dead. A few feet from No. 2 the alkali was so strong, No. 9, that only salt grass and alkali weeds would grow in it. Where the trees Nos. 6 and 7 were dead or dying

FIG. 3.—Alkali field with Eucalyptus globulus on border.

FIG. 4.—Eucalyptus globulus on border of alkali field. Alkali weeds in foreground.

the cause seemed to be the great excess of alkali salts, which covered the ground with a white incrustation and prevented proper aeration; that the common salt alone was not responsible is shown by the fact that tall trees have been found in other places growing well in as much as .50 per cent or an equivalent of about 40,000 pounds per acre in two feet depth.

It will be seen from the table that where there was as much as .48 per cent of alkali salts, comprising very high per cents of carbonate or common salt the *E. globulus* was dying when 7 feet high; and that where there was as much as .09 per cent of carbonate of soda (14,400 pounds per acre), only salt grass and alkali weeds will grow; that salt grass alone grew in presence of .49 per cent of sulfates and .12 per cent of common salt; and that nothing at all was able to live in .84 per cent of total salts (134,400 pounds per acre) in which there was .12 per cent of carbonate and .14 per cent of common salt.

Groves of E. globulus in other Localities.—A grove of *E. globulus* near Centralia schoolhouse, a few miles southwest of Buena Park, was planted in 1909 in a strip of alkali land and the trees showed varying effects of the alkali salts. The grove was visited by Mr. F. E. Johnson and soils taken from near a number of the trees and examined. The greatest height of the unaffected trees was 3 feet and the one of this height selected was growing in 19,200 pounds of salts, the greater part of which was sulfates. Other trees more or less affected are given in the table below.

In the region around Fresno were found many old trees growing in alkali soils, some of which were examined by Mr. Johnson; No. 5, about twenty-five years old, tall and having a diameter of about 15 inches, showed no indication of injury from the alkali; No. 6, twenty-five years old, thirty-five feet tall and having a diameter of 12 inches was growing in a locality whose soils seemed to be strongly charged with alkali salts and underlaid at a depth of about 3 feet by hardpan. It was, however, but slightly affected by the alkali although there was a large (.05 per cent) amount of carbonate of soda. No. 7, eight years old, was severely affected by the strong alkali about its roots, was sickly in appearance and many of its leaves were reddish in color; and No. 8, six years old, growing in a soil having .14 per cent (22,400 pounds per acre 4 feet) of carbonate of soda was stunted in growth though otherwise showing no effects of the alkali. This is the largest amount of carbonate of soda found in the soil of any eucalypt (except an unidentified species) that had attained any considerable growth. Unfortunately, the early treatment of the tree is not known, but it was doubtless well cared for and the alkali kept from the young roots until they had passed beyond the danger zone.

The results of the soil examination are given in the following table:

E. GLOBULUS IN ALKALI SOILS.

Tree No.	Age, years	Height	Effect of alkali.	Percentage in soil.				Pounds per acre, 4 feet.			
				Sulfates	Carbonates	Chlorids	Total	Sulfates	Carbonates	Chlorids	Total alkali
			Centralia Schoolhouse.								
1	1	36 in.	None	.08	.02	.02	.12	12,800	3,200	3,200	19,200
2	1	30 in.	Slight	.14	.01	.03	.18	22,400	1,600	4,800	28,800
3	1	24 in.	Moderate	.15	.01	.02	.18	24,000	1,600	3,200	28,800
4	1	14 in.	Severe	.20	.05	.05	.30	32,000	8,000	8,000	48,000
			Near Fresno.								
5	25	Tall	None	.50	.05	.03	.58	80,000	8,000	4,800	92,800
6	25	35 ft.	Slight	.02	.05	.05	.12	3,200	8,000	8,000	19,200
7	8	-------	Sickly	.08	.07	.04	.19	12,800	11,200	6,400	30,400
8	6	-------	Stunted	.11	.14	.03	.28	17,600	22,400	4,800	44,800

In the above table there is seen to be a regular gradation in height of the young trees near Centralia schoolhouse from 30 inches to 14 inches following the increasing amounts of alkali salts from .12 to .30 per cent (19,000 to 48,000 pounds per acre) in 4 feet depth, and the conclusion is inevitable that this increase has something to do with the dwarfing or retarding of the growth. It is clear that .02 per cent of carbonate of soda in 4 feet depth per acre has no effect on the young tree, while it would seem that the tree does severely feel the presence of a little more than twice that amount.

When, however, we turn to the older trees from near Fresno, we find that they are not at all affected by these amounts, and are growing well in as much as .07 per cent (11,200 pounds per acre) each of the carbonate and chlorid in four feet depth, though stunted in the presence of .14 per cent of carbonate of soda. Evidently the delicate roots have managed to escape contact with this large amount of carbonate of soda, and had passed beyond the danger point before the alkali returned to the surface. The sulfates even to the extent of .5 per cent or 80,000 pounds per acre 4 feet depth also seem not to be hurtful to the tree.

This table is very instructive and from it we must conclude that the tender bark of the roots of the *globulus* when very young are very susceptible to corrosion and injury by as much as .05 per cent or 8,000 pounds of carbonate of soda in four feet depth; but if, by irrigation, the alkali can be carried down to several feet below the surface and kept there by proper cultivation and mulching of the surface soil until the tree is able to send the roots deeply and far out laterally beyond the alkali, and has time to envelope the surface roots with a thick bark not susceptible to the alkali, there may be present double the amount of alkali without injury to the tree.

The accompanying photograph Fig. 5 is of a *globulus*, 75 feet high, growing in an alkali soil west of Wasco, Kern County. When young, the tree had had thorough irrigation from an artesian well on the place which had carried the greater part of the alkali salts to a depth below five feet, as was shown by an examination of a seven-foot column of the

FIG. 5.—Eucalyptus globulus in alkali soil. Effect of irrigation.

soil taken a few years ago; at that time there was .05 per cent of alkali in the upper four feet and .14 per cent in the lower three feet. The sulfates and chlorid were chiefly in the lower part of the column while the carbonate of soda was about evenly distributed throughout.

E. globulus in Salt Marshes and Tule Islands.—The swamp and tule lands, that mark the junction of the two great rivers of the Sacramento and San Joaquin lying in the great valley and covering approximately 1,000 square miles, are largely at or near tide water or sea level, and intersected irregularly by sloughs which divide the region into many "islands," whose lands have to be protected against overflow from the rivers by levees before being capable of safe cultivation and crop production. The water of these sloughs, as well as of the rivers for many miles upstream, are more or less mixed with the salty tide water of the bay, and by percolation the salt has been carried into the lands of the islands, as well as rising into the levees that surround them.

Along the levees of a number of these islands there were planted many years ago long rows of eucalypts, mostly of the *globulus* variety, to serve as windbreaks. These trees have grown to heights of from 40 to 60 or more feet although some of their roots are bathed constantly by salt water, and others are living in a soil of but two or three feet above water level and carrying a high percentage of salts.

Similarly, the salt marshes that border the bay of San Francisco in Marin County, known as the Novato Meadows, have many trees growing in the shallow and more or less salty soil.

Samples of soil from very near some of these trees of the Novato Meadows, and from one of the "islands" were taken down to the water level (two feet), and subjected to analysis with the following results:

E. GLOBULUS IN ALKALI SOILS OF MARSH AND TULE LANDS.

	Percentages.			Pounds per acre, 2 feet.		
	Sulfates.	Chlorids.	Total.	Sulfates.	Chlorids.	Total.
Tule Island	.69	.56	1.25	55,000	44,800	99,800
Novato Meadows	.14	.42	.56	11,200	33,600	44,800

These are very large amounts of each salt and plainly show that the *globulus* is not sensitive to the presence of either sulfate of soda or common salt in its soils. There was no carbonate of soda in soils examined.

We find, then, that *Eucalyptus globulus*, after passing the young stage of growth and getting its roots deeply in the soil, will withstand a large amount of alkali salts, provided the carbonate of soda does not exceed .05 per cent.

EFFECT OF ALKALI ON E. RUDIS.

In the alkali plot of the Tulare Experiment Station there were planted 25 young seedlings of *E. rudis*, eight of which reached a maximum height of 36 inches during the first season after planting both in a soil having but little alkali and in the spot having as much as .14 per cent or

nearly 17,000 pounds per acre in 3 feet depth, of which nearly one half was carbonate of soda. Twelve others of the seedlings grew from 24 inches to 36 inches, and the others from 15 to 24 inches. None of the young trees were killed by the alkali, though some were dwarfed and failed to reach the height they should have done.

E. RUDIS IN ALKALI SOILS: TULARE STATION.

Tree No.	Height, inches.	Condition.	Percentage in soil.				Pounds per acre, 3 feet.			
			Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.
5	36	Good	.05	.08	.01	.14	6,000	9,600	1,200	16,800
13	27	Leaves affected	.26	.05	.02	.33	31,200	6,000	2,400	40,600
6	24	Good	.21	.07	.02	.30	25,200	8,400	2,400	36,000
11	20	Good	.24	.06	.02	.32	28,800	7,200	2,400	38,400
7	18	Good	.35	.05	.01	.41	42,000	6,000	1,200	49,200
14	18	Good	.16	.05	.03	.24	19,200	6,000	3,600	28,800
9	15	Good	.17	.07	.01	.25	20,400	8,400	1,200	28,000

Unfortunately for the experiment, the row of young seedlings did not cross the part of the plot having the strongest alkali, and hence were not subjected to as severe a test as the *cornuta* and *globulus*, where the maximum amount of alkali salts was .51 per cent or about 61,000 pounds per acre in 3 feet depth.

The maximum amount of total salts in the *rudis* test was .41 per cent or about 49,200 pounds per acre, and in this the seedling reached a height of 18 inches. The lowest height of any tree was 15 inches and this was in the presence of only .25 per cent or 28,000 pounds per acre, but in this there was .07 per cent (8,000 pounds per acre) of carbonate of soda. That other conditions than alkali alone had affected the *rudis* was shown in seedlings Nos. 7 and 14, each with a height of 18 inches and in whose soils there was respectively .41 and .24 per cent of alkali, and in which the carbonate and the chlorid were almost the same in amount. In other places also where there was but little alkali the growth was very small.

Conditions in 1910.—Observations made on the *rudis*, a year later than above and after the station had been abandoned leaving the plot entirely neglected, showed that eleven of the young trees had died, comprising those in the center of the row and where a dense and tall growth of alkali weed had appeared. However, seven of the trees in this weed patch had increased from 24 to 36 inches in height and two more were holding their own and were the only eucalypts living within this area, with the exception of one each of *tereticornis* and *crebra* which were in the edges of the weeds. The killing out of the trees was due doubtless to the lack of water and to the presence of the weeds, as

the amount of carbonate of soda present in their soils was less than in No. 5, which still lived in .08 per cent.

Other Localities.—In the investigations made by Mr. Johnson in other parts of the State, samples of alkali soil were taken from twenty-five or more of the *E. rudis* and submitted to analysis. The greater number of these had less alkali than could produce unfavorable effects upon the tree and all but nine have been omitted from the table.

The first tree given in the following table was from near Fresno; it was three years old, 8 feet high, and well proportioned and showed no bad effect of the .20 per cent of alkali in its soil. No. 2 from Kingsburg also was in good health, though growing in a soil with .25 per cent of alkali salts, and had received no cultivation. No. 3 from Hanford, 5 feet high, had received fairly good cultivation and was not suffering from the .28 per cent of alkali in its soil, which was equal to nearly 50,000 pounds per acre in 4 feet depth. A detailed analysis of each foot showed that the carbonate of soda was distributed rather evenly through the four-foot column, that three fifths of the sulfates and of the chlorids also were in the first foot and one fifth in the second foot. The water level was at five feet. No. 4 from Kingsburg had received no cultivation and was growing in hard ground covered with weeds and salt grass. A gravelly hardpan occurred at two feet below the surface but the roots of the tree had passed through it into the soil below. Notwithstanding these drawbacks and the presence of .24 per cent of alkali salts, the tree was not suffering. No. 5 from Hanford, three years old and 15 feet high, was growing in a soil covered with a powdery coating of alkali and holding .20 per cent of alkali. Grapes had all died in this soil, but the *rudis* showed no marked ill effect except in smaller leaves and red spots. No. 6 from the same place had been planted in a barrel filled with good soil and covered over with manure and sunk into the alkali-crusted soil; the seedling reached a height of 6 feet in two years, but the alkali became diffused into the soil of the barrel and the tree began to show some bad effects. No. 7 from Fresno had apparently died down and again grown up from a sucker; it looked very badly though 5 feet high, many of the tips of the shoots being dead and some of the leaves mottled red, though the amount of alkali was not large. No 8 from near Fresno was 6 feet tall, with but few branches and some of the leaves near the ends of the branches being mottled red. No. 9 from Hanford, one year old standing in strong alkali soil, crusted over with alkali was alive but not growing.

E. RUDIS IN ALKALI SOILS.

Tree No.	Locality.	Age, years.	Height, feet.	Effect of alkali.	Percentage in soil.				Pounds per acre, 4 feet.			
					Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.
1	Fresno	3	8	No effect	.09	.05	.06	.20	14,400	8,000	9,600	32,000
2	Kingsburg	3	----	No effect	.13	.04	.08	.25	20,800	6,400	12,800	40,000
3	Hanford	2	----	No effect	.16	.07	.05	.28	25,600	11,200	8,000	49,800
4	Kingsburg	5	----	No bad effect	.13	.04	.07	.24	20,800	6,400	11,200	38,400
5	Hanford	3	15	Leaves spotted red	.14	.05	.01	.20	22,400	8,000	1,600	32,000
6	Hanford	2	6	Leaves spotted red	.04	.08	.01	.13	6,400	12,800	1,600	10,800
7	Fresno	----	5	Mottled red leaves	.05	.04	.03	.12	8,000	6,400	4,800	19,200
8	Fresno	----	6	Mottled red leaves	.09	.07	.06	.22	14,400	11,200	9,600	35,200
9	Hanford	1	----	Alive, but not growing	.04	.09	.01	.14	6,400	14,400	1,600	22,400

There is not much to be said regarding these results, except that the *rudis* was not affected by as much as .28 per cent or 45,000 pounds of total alkali salts per acre in a depth of 4 feet, even when .07 per cent or 11,200 pounds of that was carbonate of soda and .05 per cent or 8,000 pounds was of common salt. We find, however, that when this amount of carbonate is increased to nearly .09 per cent or 15,000 pounds as at Hanford, the tree failed to grow though keeping alive.

Several of the trees with less amounts of carbonate of soda had leaves on some of the branches that were mottled with red spots. These spots have been regarded as the effect of the alkali, but this is doubtful, as we find in the Tulare experiments that very young trees, less than a year old, were not thus affected even in 9,000 pounds of carbonate of soda. A height of 6 feet in two years is very good for the *rudis* and even if the mottled leaves are thus colored by alkali the growth does not seem to be injured.

On comparing these with the results of the special test on the alkali spot at Tulare Station given above, we find that the figures of tolerance in the latter are higher.

The *E. rudis* will evidently grow well in a soil containing as much as .08 per cent of carbonate of soda, if other conditions are favorable.

EFFECT OF ALKALI SALTS UPON E. TERETICORNIS.

The only observations made upon this species of Eucalyptus were those of the special plot of the Tulare Station. In this plot there were planted thirty-one young seedlings of the *E. tereticornis* in two rows, but not across the strongest alkali, as will be seen from the chart. It was perhaps unfortunate that the test could not have made more severe along with the *globulus, rudis,* etc., for the *tereticornis* is regarded by some as being one of the best alkali-resistant eucalypts; this is, however, not borne out by the Tulare tests, for in the entire number of young trees there were but three that reached the height of from 36 to 48 inches without showing some sign of distress, as shown either in the small growth, or in the yellowing of the leaves, or in tipping them with red, a condition which seems to come from the alkali. Twelve of the thirty-one seedlings (38.7 per cent) died completely, while others had nearly succumbed at the end of the first year. Twelve were from 12 to 24 inches high and two not more than 10 inches. Twelve of the young trees were selected for the examination of the alkali content of their soil and samples of the latter were taken to depths of 3 feet. The results of the analyses are given in the following table, which is arranged from highest to lowest of tree growths:

E. TERETICORNIS IN ALKALI SOILS: TULARE STATION.

Tree No.	Height, inches	Condition of tree.	Percentage in soil.				Pounds per acre, 3 feet.			
			Sulfates	Carbonates	Chlorids	Total	Sulfates	Carbonates	Chlorids	Total
1	24	Well branched, trunk ½ in. diameter	.09	.04	.01	.14	10,800	4,800	1,200	16,800
14	24	Two lower limbs affected	.18	.04	.02	.24	21,600	4,800	2,400	28,800
3	18	Few leaves dying	.06	.07	.01	.14	7,200	8,400	1,200	16,800
6s	18	Few lower leaves dying	.06	.05	.01	.12	7,200	6,000	1,200	14,400
7	12	Leaves spotted red	.13	.07	.01	.21	15,600	8,400	1,200	25,200
7s	12	Yellow leaves, spotted red, some dead	.05	.05	.01	.11	6,000	6,000	1,200	13,200
10s	8	Small leaves, spotted red	.12	.05	.01	.18	14,000	6,000	1,200	21,200
8s	8	Nearly dead	.08	.05	.01	.14	9,600	6,000	1,200	16,800
5	6	Dead	.07	.07	.01	.15	8,400	8,400	1,200	18,000
9	4	Dead	.13	.08	.02	.23	15,600	9,600	2,400	27,600
11	----	Dead	.17	.07	.01	.25	18,400	8,400	1,200	28,000
13	----	Dead	.22	.06	.04	.32	26,400	7,200	4,800	38,400

The maximum of total salts was .32 per cent or an average of 38,400 pounds per acre in 3 feet depth; that of carbonate of soda was .08 per cent or 9,600 pounds per acre, and that of the chlorid or common salt was .04 per cent or 4,800 pounds per acre in 3 feet depth. In the presence of each of these amounts the young tree had died, and was nearly dead in smaller amounts.

The alkali sulfates are seen in the above table to have had very little

effect on the young trees; and the common salt was not in excess in the soil of any of the trees.

The carbonate of soda appears to be the sole cause of injury from alkali, and we find that when the amount was in excess of .04 per cent or 4,800 pounds per acre in 3 feet depth the leaves began to die or turn yellow, while in larger amounts than .07 per cent or 8,400 pounds per acre the seedlings succumbed.

The maximum growth of 48 inches was reached in the presence of .03 per cent or 3,600 pounds of carbonate of soda in a total of only .16 per cent or about 19,000 pounds per acre.

The above is a poor showing for the *tereticornis* and indicates that the tree will not attain a good growth if as much as .05 per cent of carbonate of soda be allowed to remain in the upper three feet of soil.

Observations in 1910.—The abandonment of the station in 1910 caused the alkali plot to be neglected and the trees sorely tested not only by lack of irrigation and by the alkali, but by the dense growth of alkali weeds that sprang up in the central part of the plot occupied by 101 eucalypts. The *tereticornis* suffered with the rest and all of the 12 trees of the two rows in the weed patch that had escaped the first effects of alkali succumbed, with the exception of one on the extreme west, which made an additional growth of 8 feet in presence of .04 per cent of carbonate of soda in its soil. Outside of this patch two trees made increased growths of several feet but all others died.

It may be safely assumed that the *tereticornis* will attain good growth in an alkali that does not contain more than .04 per cent of carbonate of soda in a depth of three or four feet.

EFFECT OF ALKALI ON E. ROSTRATA.

Young *rostrata* seedlings were planted in the special alkali plot of the Tulare Station, but unfortunately not through the strongest part, the maximum of alkali in the two rows being but .24 per cent or 28,800 pounds per acre in 3 feet depth. The amount of carbonate of soda in a portion of the rows was, however, quite high.

The number of seedlings planted was 54 and all but three of these remained alive at the end of the first season, though many were greatly retarded in growth. The maximum height at the end of the first year was 48 inches in a good soil which had as much as .05 per cent or 6,000 pounds of carbonate of soda per acre in 3 feet depth. But two of the seedlings reached this height, ten were 36 inches, seventeen were 24 inches and twenty-two were 12 inches high.

Soils three feet deep from a number of the typical trees were exam-

ined as to alkali contents and the results are given in the following table:

E. ROSTRATA IN ALKALI SOIL: TULARE EXPERIMENT STATION.

Tree No.	Height, inches	Condition of tree.	Percentage in soil.				Pounds per acre, 3 feet.			
			Sulfates	Carbonates	Chlorids	Total	Sulfates	Carbonates	Chlorids	Total alkali
1	48	Good; long branches	.07	.05	.01	.13	8,400	6,000	1,200	15,600
8s	46	Good; long branches	.09	.04	.01	.14	10,800	4,800	1,200	16,800
8	36	Good; long branches	.06	.07	.01	.14	7,200	8,400	1,200	16,800
13	36	Good	.13	.03	.01	.17	15,600	3,600	1,200	20,400
10s	30	Good	.18	.01	.02	.21	21,600	1,200	2,400	25,400
3	24	Slim, lowest leaves affected	.05	.05	.01	.11	6,000	6,000	1,200	13,200
5s	24	Healthy, except few bottom leaves	.11	.03	.01	.15	13,200	3,600	1,200	18,000
4	20	Short limbs, leaves have die-back	.06	.06	.01	.13	7,200	7,200	1,200	15,600
6s	18	Healthy, except lower leaves	.16	.05	.02	.23	19,200	6,000	2,400	27,600
12	18	Healthy, except three lower leaves	.10	.06	.01	.17	12,000	7,200	1,200	20,400
34	12	Dying, some leaves dead	.19	.03	.02	.24	22,800	3,600	3,200	28,800
33	12	Leaves slightly yellow	.07	.07	.01	.15	8,400	8,400	1,200	18,000
6	12	Leaves tipped dark	.12	.02	.02	.16	14,400	2,400	2,400	19,200
15	14	Tree healthy	.10	.03	.01	.14	12,000	3,600	1,200	16,800
7	----	Dead	.08	.07	.01	.16	9,600	8,400	1,200	19,200
10	----	Dead	.05	.07	.01	.13	6,000	8,400	1,200	15,600

The *rostrata* reached its greatest height of 48 inches in presence of .05 per cent of carbonate of soda, and 36 inches in presence of .07 per cent—thus nearly equalling the *rudis*. There is not much to be said regarding other results, as the failure to do well on the part of any one of the young seedlings can not be attributed to any particular salt so far as we can determine unless it be carbonate of soda. The highest amount of total alkali in 3 feet depth in the two rows of seedlings was but .28 per cent or about 29,000 pounds per acre, and this was in a small spot in the extreme east end of the row where a few had been planted; the alkali here formed a loose covering on the ground and one of the trees, No. 34, was dying, seemingly from its effects combined with the .03 per cent of carbonate. In another place where there was a less amount of total alkali, but more of carbonate of soda, the tree (No. 6 s) was but 18 inches high and the lower leaves were dying. Other trees, where the amount of total salts was rather small but the carbonate of soda high, were dead, thus indicating that the carbonate of soda was responsible for the injury.

Where the total salts are less than .24 per cent we find that the seedling was not affected by as much as .05 per cent of the carbonate of soda; but that when the carbonate is increased to .07 per cent (8,400 pounds per acre in 3 feet depth) the leaves turned yellow. The common salt may have had something to do with the injurious effect, but the amount necessary for this does not appear in the table.

Observations in 1910.—Observations made on the Eucalyptus plot in the Tulare Station after the latter had been abandoned showed that all

of the first twelve trees of the north row had been killed, either by lack of water or by the dense mass of alkali weeds that had sprung up over the central part of the plot; the five trees of the south row included in this weed patch were also killed. All the living trees, on the outside of the patch and chiefly on the east where the weeds apparently could not grow, had made increased growth of several feet. Tree No. 15 had grown to 24 inches and No. 13 to 8 feet. In the soil of both of these trees there was but .03 per cent of carbonate of soda. On the west end of the south row, two of the trees outside of the weed patch were each 10 feet high, which was an increased growth of 6 feet in a soil containing

FIG. 6.—Eucalyptus rostrata in alkali soil; Miramonte, Kern County.

.05 per cent of carbonate of soda and which had received no irrigation during the summer.

Other Localities.—Trees of *E. rostrata* in other parts of the State were found apparently growing well in strong alkali salts and samples of their soils were taken for examination. Near Miramonte, Kern County, a group of trees six years old had a height of about 30 feet; when young they had been irrigated, but of late years have been entirely neglected and were surrounded with salt grass and alkali weeds. In this soil there was but little carbonate of soda, while the amounts of sulfate of soda and common salt were extremely large, the total being .80 per cent or 128,000 pounds per acre in 4 feet depth. Tree No. 2 was obtained near Fresno, four years old and showing no effect of the alkali salts. Nos. 3 and 4 are from Centralia schoolhouse near

Buena Park, Orange County, each a year old; one showing no effect and the other but little effect of the salts and each having about the same height. No. 5 from Buena Park, two years old and 7 feet high, in a soil having an enormous amount of alkali, but composed chiefly of sulfate of soda and common salt, showed but little injury. No. 6, from Visalia, three years old, 6 feet high, was surrounded by a crust of alkali two to three inches deep, the effect being seen in the straggling branches of the tree. Nos. 7 and 8, from Centralia, each a year old and two feet high, showed somewhat the effect of the alkali, the latter tree having some dead leaves. No. 9, from near Bakersfield, one year old, was suffering, but it was thought would live. No. 10 grew in the middle of a strip of alkali and was small and stunted. Nos. 11 and 12 were barely alive.

E. ROSTRATA IN ALKALI SOILS.

Tree No.	Locality.	Age, years.	Height.	Effect.	Percentage in soil.				Pounds per acre, 4 feet.			
					Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.
1	Miramonte	6	30 ft.	None	.70	.01	.09	.80	112,000	1,600	14,400	128,000
2	Fresno	4	-------	None	.09	.04	.01	.14	14,400	6,400	1,600	23,400
3	Centralia	1	2½ ft.	None	.10	.03	.02	.15	16,000	4,800	3,200	24,000
4	Centralia	1	3 ft.	Some	.11	.05	.02	.18	17,600	8,000	3,200	28,800
5	Buena Park	2	7 ft.	Some	1.48	.01	.22	1.71	236,800	1,600	35,200	273,600
6	Visalia	3	6 ft.	Some	.02	.08	.01	.11	3,200	12,800	1,600	17,600
7	Centralia	1	2 ft.	Some	.13	.05	.03	.21	20,800	8,000	4,800	33,600
8	Centralia	1	2 ft.	Some	.14	.03	.02	.19	22,400	4,800	3,200	30,400
9	Rio Bravo	1	-------	Some	.15	.01	.17	.33	24,000	1,600	27,200	52,800
10	Centralia	1	18 in.	Stunted	.17	.04	.02	.23	27,200	6,400	3,200	41,800
11	Rio Bravo	1	-------	Barely alive	.89	.02	.12	1.03	142,400	3,200	19,200	164,800
12	Rio Bravo	1	-------	Barely alive	.34	.06	.12	.52	54,400	9,600	19,200	83,200

These results appear very contradictory in regard to the amount of the several salts tolerated by the *rostrata,* and we are obliged to conclude that other causes have combined with the alkali to injure some of the trees. Some of the results are remarkable and show that under proper conditions or treatment the tree may be enabled to withstand the effect of very high percentages of each of the several salts comprising the alkali. Thus, we find that a two-year-old tree at Buena Park has reached the height of 7 feet and has suffered but little in the presence of one and one half per cent of sulfates and two tenths per cent of common salt in 4 feet depth; but there was but little carbonate of soda. These percentages represent 236,800 pounds of sulfates and 35,200 pounds of common salt per acre in that depth. Then, too, a three-year-old tree at Visalia, 6 feet high, suffered but little except in height in a soil having .08 per cent of carbonate of soda or an average of 12,800 pounds per acre in 4 feet depth. Doubtless these large amounts of alkali were largely below the reach of the tender tree roots during the

first year of growth and did not rise until the bark of the roots was strong enough to resist, thus giving time to grow downward and laterally away from the alkali.

The results thus give strong evidence of the importance of thorough and deep irrigation of Eucalyptus and other orchards in alkali lands to keep the alkali down out of reach of the roots until the latter themselves can develop and extend beyond the alkali zone.

EFFECT OF ALKALI ON EUCALYPTUS BOTRYOIDES.

No tests were made with the *botryoides* at the Tulare Station. A tree identified as *E. botryoides* was found near Kingsburg in a soil apparently strongly alkaline in character; it looked fairly well, better than a *rostrata* standing near, but seemed to show some slight injurious effect of the alkali. Black walnut trees in an adjoining lot looked very badly, half of their leaves being dead. The ground around the eucalypts had been well cultivated.

Another *botryoides*, about twelve years old, was found growing in an alkali soil near Fresno; the top was dead and the tree in a very bad condition from the alkali salts.

Samples of the soils of these two trees were taken to depths of four feet and their alkali contents ascertained as shown in the following table:

E. BOTRYOIDES IN ALKALI SOILS.

Locality.	Condition.	Percentage in soil.				Pounds per acre, 4 feet.			
		Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total.
Kingsburg	Slightly affected	.04	.05	.01	.10	6,400	8,000	1,600	16,000
Fresno	Tops dead	.03	.04	.03	.13	9,600	6,400	4,800	20,800

While the tree from Kingsburg suffered but little in .05 per cent of carbonate of soda, that from Fresno, with much less carbonate in the soil but with much more common salt, was severely affected. The former tree had received good treatment, and it is to be presumed that the latter had not.

The age and height reached by these trees would indicate that with proper irrigation methods the *botryoides* can be made to withstand as much as .05 per cent of carbonate of soda in its soil without injury.

EFFECT OF ALKALI ON EUCALYPTUS ROBUSTA.

Seedlings of the Eucalyptus *robusta* were not planted in the special alkali plot of the Tulare Experiment Station, but there are two trees, one large, the other small, growing near the station fence in the Eucalyptus row which are many years old. There is some alkali in their soils as shown in the analyses given in the table.

In his search through the San Joaquin Valley, Mr. Johnson found five trees that have been identified by Professor Hall as *robusta*, growing in alkali soils. One at Kingsburg, about five years old, was but slightly affected, though it had received no cultivation and was surrounded with weeds and salt grass; a gravelly hardpan occurred at two feet below the surface, but the roots of the tree had made their way through it into the soil below.

The other trees were found near Fresno; No. 4 was two years old, about 15 feet high and showed no effect of the alkali; No. 5 was about 12 feet high, had received no cultivation, and was somewhat stunted in growth, though otherwise apparently in healthy condition; No. 6, six years old, was sickly in appearance and the edges of its leaves were dead though the tree was in full bloom. No. 7, eight years old, also appeared sickly. Its soil contained .07 per cent of carbonate of soda, or an equivalent of about 11,200 pounds per acre in 4 feet depth: the owner of the land remarked that nothing would grow upon it before the eucalypts were planted.

The alkali content of the soils of these trees is given in the following table:

E. ROBUSTA ON ALKALI SOIL.

Tree No.	Locality.	Age, years.	Height, feet.	Effect of alkali.	Percentage in soil.				Pounds per acre, 4 feet.			
					Sulfates.	Carbonates.	Chlorids.	Total.	Sulfates.	Carbonates.	Chlorids.	Total alkali.
1	Tulare			Small tree	.07	.03	.06	.16	11,200	4,800	9,600	25,600
2	Tulare			Large tree	.14	.02	.03	.19	22,400	3,200	4,800	30,400
3	Kingsburg	5		Slight effect	.12	.04	.08	.24	19,200	6,400	12,800	38,400
4	Fresno	2	15	Not affected	.05	.06	.02	.13	8,000	9,600	3,200	20,800
5	Fresno	2	12	Somewhat stunted	.06	.03	.04	.13	9,600	4,800	6,400	20,800
6	Fresno	6		Sickly	.09	.04	.04	.17	14,400	6,400	6,400	27,200
7	Fresno	8		Sickly	.08	.07	.04	.19	12,800	11,200	6,400	30,400

The treatment given the trees of the above table while young is not known, but it is evident, as remarked above, that if proper care is taken, and irrigation water applied in sufficient amount to keep the alkali down several feet and enable the young, tender rootlets to pass beyond the danger zone, before the alkali returns to the surface, a good healthy

growth may be secured in presence of even as much as .06 per cent of carbonate of soda, which is equivalent to nearly 10,000 pounds per acre. This is shown by tree No. 4 from Fresno.

Common salt has but little if any effect, for tree No. 3 from Kingsburg has withstood as much as .08 per cent (nearly 13,000 pounds per acre), even without cultivation and with other unfavorable conditions.

On the other hand, No. 7 seems to have been affected by .07 per cent of carbonate of soda (nearly 12,000 pounds per acre in 4 feet). From this we would judge that a percentage of .06 of carbonate of soda is about the upper limit of tolerance on the part of the *robusta*.

EFFECT OF ALKALI ON OTHER SPECIES OF EUCALYPTUS.

Species of Eucalyptus, other than those with which experiments have been made in the alkali plot, are growing along the south fence of the Tulare Station, having been planted in 1888 and have reached heights of from 50 to 100 feet. The list of trees in the row, beginning at the corner of the station comprise the following (as identified by Prof. H. M. Hall from specimens of flowers, etc.); the amounts of alkali salts occurring in their respective soils to a depth of four feet is given in the table:

ALKALI SALTS UNDER ROW OF EUCALYPTUS ALONG THE FENCE: TULARE STATION.

Tree No.	Species.	Percentage in soil.				Sulfates.	Carbonates.	Chlorids.	Total.
		Sulfates.	Carbonates.	Chlorids.	Total.				
1	Robusta	.142	.015	.028	.185	22,720	2,400	4,480	29,600
2	Crebra	.074	.017	.019	.109	11,840	2,720	3,040	17,600
3	Sideroxylon	.121	.010	.046	.178	19,360	1,600	7,360	28,320
4	Gunnii	.133	.007	.046	.186	21,280	1,120	7,360	29,760
5	Gunnii	.084	.019	.046	.149	13,440	3,040	7,360	23,840
6	Sideroxylon	.070	.014	.037	.121	11,200	2,240	5,920	19,360
7	Corynocalyx	.057	.029	.028	.114	9,120	4,640	4,480	18,240
8	Robusta	.074	.024	.060	.158	11,840	3,740	9,600	25,180
9	Gunnii	.117	.015	.037	.170	18,720	2,400	5,920	27,040
10	Corynocalyx	.022	.009	.019	.049	3,520	1,440	3,040	8,000
13	Rostrata	.060	.012	.009	.081	9,600	1,920	1,440	12,960
14	Sideroxylon	.044	.015	.037	.093	7,040	2,400	5,920	15,360
15	Rostrata	.056	.019	.037	.112	8,960	3,040	5,920	17,920
----	Amygdalina	.217	.017	.019	.253	34,720	2,720	3,040	40,480

In the row of trees the *amygdalina, Gunnii* No. 4 and the *rostrata* No. 1 were growing in stronger total alkali than any others, while the *corynocalyx* No. 7 is in the strongest carbonate of soda, .029 per cent. The soil of the *robusta* No. 8 has the highest amount of common salt, .06 per cent, the equivalent of nearly 10,000 pounds per acre in 4 feet.

Young seedlings of all of the above species of Eucalyptus, excepting the *amygdalina, botryoides, sideroxylon, Gunnii,* and *robusta,* have been

experimented with in the Tulare Station plot and the results are given on previous pages of this bulletin; the *robusta* and *botryoides*, on which observations were made in other parts of the State, are also discussed above with other species.

E. sideroxylon. There are three trees of this species growing in the Eucalyptus row at Tulare as shown above in the table, but in their soils there is but a small amount of alkali salts, the largest being .178 per cent. The highest percentage of carbonate of soda is in the soil of No. 14 where we find .015 per cent or the equivalent of 2,400 pounds per acre, which is quite small in a four-foot column. The largest amount of common salt is with the soil of the same tree which contains .046 per cent, or nearly 7,500 pounds per acre 4 feet depth.

The *sideroxylon* can, without doubt, withstand the effects of much larger amounts of alkali salts than found under these trees.

E. Gunnii. Seedlings of *E. Gunnii* were not planted in the test plot of the Tulare Station, and the only trees of this species growing in alkali lands that we know of are the three in the row along the station fence at Tulare, as given in the above table. The alkali in the soil of No. 4 is greater than in that of any of the trees of the row (.186 per cent) but is not excessive. The highest carbonate of soda under the *Gunnii* is .019 and of common salt .046 per cent, and these have not produced any apparent injury. Both the *sideroxylon* and the *Gunnii* can, almost without doubt, withstand as much carbonate of soda as other species of eucalypts which has thus far been placed at .04 per cent in a depth of three feet.

E. amygdalina.—The *amygdalina* is standing in a soil containing the highest total alkali of the group, .253 per cent, or about 40,000 pounds per acre in 4 feet depth, but the amounts of carbonate and common salt are only .017 and .019 per cent (2,700 and 3,000 pounds) respectively. The species can without doubt do well in as much as .04 per cent of carbonate of soda.

SUMMARY OF RESULTS.

The highest percentage of carbonate of soda found in the soils of the respective species of eucalypts, and the condition of the tree in presence of these percentages, both in the seedling test-plot at Tulare and at outside places are given in the following summary:

Species.	Tulare seedlings: soils 3 feet deep.			Trees growing elsewhere; soils 4 feet deep.		
	Carb. soda. per cent.	Condition.	Height.	Carb. soda. per cent.	Condition.	Height.
Crebra	.10	Dying	6 inches	.02	Healthy	Tall
	.08	Dying	10 inches			
	.07	Poor growth	6 inches			
Rudis	.08	Good	36 inches	.09	Not growing	
	.07	Good	24 inches	.08	Leaves spotted	6 feet
Tereticornis	.07	Leaves dying	18 inches			
	.08	Dead	4 inches			
Corynocalyx	.08	Leaves dying	18 inches	.07	Leaves yellow	25 feet
	.05	Dead	6 inches			
Globulus	.07	Dwarfed	18 inches	.14	Stunted, not thrifty	
	.06	Dead	8 inches	.07	Sickly; 8 years old	
Rostrata	.07	Good	36 inches	.08	Not full grown; 3 years old	
	.05	Good	48 inches	.05	Little effect	
Cornuta	.07	Leaves dying	20 inches			
	.05	Dead	24 inches			
Robusta				.07	Sickly	
				.06	Not affected	6 feet
Botryoides				.05	Slightly affected	
Sideroxylon				.02	Large tree not affected	
Gunnii				.02	Large tree not affected	
Amygdalina				.02	Large tree not affected	

Among the young trees at Tulare in the above table the *crebra* was exposed to the highest amount of carbonate of soda, but only grew a few inches and finally died. The *rudis* alone made good growth in as much as .08 per cent, though with .09 per cent in an outside grove it was alive but not growing. The *rostrata* in an outside grove three years old had its growth retarded by .08 per cent, but at Tulare the seedling made good growth of 36 inches in presence of .07 per cent. The *globulus* was stunted by .14 per cent, made less than half growth with .07 and was dead with .06 per cent of carbonate of soda.

The highest amount of carbonate of soda found in any soil during this investigation was .20 per cent (32,000 pounds per acre) in a depth of 4 feet in a Eucalyptus plantation near Pixley. A two-year-old tree growing in it, not identified but supposed by Mr. Johnson to be a *corynocalyx*, had made a growth of but 3 feet. It was in a sandy soil, and

had had good cultivation and irrigation, which had evidently kept the corrosive carbonate of soda below the tender surface roots, thus affording a good illustration of what proper treatment will do in helping a seedling to escape severe injury in a soil containing large amounts of alkali salts. The next highest amount of carbonate of soda given in the tables above was that of .14 per cent in which a *globulus* was slowly growing.

The following table presents the highest percentages of carbonate of soda found in the soil of such seedlings of each species of Eucalyptus that at the end of the first season at Tulare had reached their highest growth and remained healthy:

Species.	Height.	Carbonate of soda.	Pounds per acre of carbonate of soda.
E. rudis	36 inches	.08 per cent	9,600
	24 inches	.05 per cent	6,000
E. crebra	6 inches	.07 per cent	8,400 little growth.
E. rostrata	48 inches	.05 per cent	6,000
	36 inches	.07 per cent	8,400
E. globulus	30 inches	.04 per cent	4,800
	18 inches	.04 per cent	4,800
E. corynocalyx	30 inches	.04 per cent	4,800
	24 inches	.04 per cent	4,800
E. tereticornis	24 inches	.04 per cent	4,800
E. cornuta	42 inches	.03 per cent	3,600
	24 inches	.04 per cent	4,800

From the above table it will be seen that the *E. rudis* among the seedlings at Tulare, reached its highest growth, unaffected, in a higher percentage of carbonate of soda than did any other species; the soil of this seedling contained .08 per cent of the carbonate or an average of nearly 10,000 pounds per acre in a depth of 3 feet. This, with the fact that not one of its seedlings was killed in the test row while all other species lost numbers of their seedlings, would seem to place the *rudis* as first among alkali-resistant eucalypts.

The *rostrata*, with its tall growth of 48 inches in .05 per cent of the carbonate, and 30 inches in .07 per cent, marks it as next to the *rudis* in its resistance to alkali effects.

While the *crebra* seem to rank next to the *rudis* with its .07 per cent of carbonate, its very slow growth of but about four inches in the season, and the general injurious effect on all of its trees, in reality places it below even the *cornuta* at the bottom of the list.

The other species, except the *cornuta* and *crebra*, so far as the present records go, are about equal in their tolerance of carbonate of soda, and we may safely place the amount at .04 per cent or about 5,000 pounds

per acre distributed in the upper 3 feet of soil; or possibly 6,500 pounds if distributed through 4 feet depth.

The eucalypts thus seem to have a higher toleration for carbonate of soda than do many orchard trees, and are apparently not sensitive to very large amounts of the sulfates and of common salt if distributed through the upper soil instead of being accumulated on the surface.

CONCLUSIONS.

A general review of the work thus far done with regard to the effect of alkali salts upon several species of Eucalyptus brings out the following conclusions based upon the results obtained:

1. The limit of tolerance of alkali salts upon the part of the Eucalyptus is greater in soils well taken care of than in poorly treated ones. Care in the cultivation and irrigation of the young trees is highly important in plantations of eucalypts, as well as in other cultures.

2. A higher percentage of alkali salts, and especially of carbonate of soda, may be tolerated by young Eucalyptus if the alkali be kept below the roots or at a depth of several feet, until the roots have passed beyond the alkali bed both downward and laterally, and the bark of the roots has become sufficiently thick to resist corrosion.

3. The carbonate of soda is proven by the observations to be the chief hurtful ingredient in alkali. The sulfates and chlorids, even in large amounts have but little injurious influence on the young eucalypts, so long as they do not form a thick crust on the surface of the ground; the *globulus* grew to a height of 60 feet on the levee of one of the islands in the tule marsh lands of the Sacramento and San Joaquin rivers, the soil of which contained about 40,000 pounds of common salt in a depth of two or three feet. The carbonate of soda may be neutralized and changed to non-injurious sulfates by the application of sufficient amounts of finely ground gypsum with an abundance of irrigation water.

4. The value of Eucalyptus trees being dependent on their size, the seedling should not be planted in alkali soil having such a percentage of carbonate of soda that would dwarf or even retard the growth, unless precautions be taken to keep the alkali below the young root system for a couple of years or more. A percentage of from .07 for many of the species and .09 for the *rudis* and *rostrata* seems to have this retarding effect on the growth, but the generous application of gypsum should counteract this.

5. Of the species of eucalypts tested at the Tulare Station, the *rudis* reached its best growth in a higher percentage of carbonate of soda than did any of the others. Its .08 per cent is equivalent to nearly 10,000 pounds per acre in a depth of 3 feet.

The *rostrata* stands next to *rudis* in its resistance to alkali at the

Tulare Station (.07 per cent) while the *globulus, corynocalyx, tereticornis,* and *cornuta,* each reached their maximum growth in but .04 per cent of carbonate of soda, being apparently retarded by a larger amount.

The *crebra,* while apparently healthy with as much as .07 per cent of carbonate of soda, had made scarcely any growth in the first season, and can hardly be called an alkali-resistant species.

6. The beneficial effects of good care and irrigation are shown by a tree supposed to be *corynocalyx* growing near Fresno in a soil containing as high as .20 per cent of carbonate of soda in a depth of 4 feet. In this instance, the alkali had evidently been largely kept away from the young rootlets by the abundant irrigation and cultivation of several years until the danger point had been passed.

7. In general, a percentage of .04 of carbonate of soda in 3 feet depth (or about 5,000 pounds per acre) was easily tolerated without injury by each of the species of eucalypts tested at Tulare, and doubtless will be by many others.

Further observations will probably place the limit of tolerance at a higher figure than at present determined for the several species.

CULTURE METHODS AND USES OF EUCALYPTUS.

(Partial Reprint from Bulletin 196.)

[The edition of Bulletin 196 of this station, entitled "Eucalyptus in California," by Mr. Norman Ingham, in charge of the Santa Monica Station, has been entirely exhausted, and the request for copies is so great that it has been thought best to reprint such portions of it as relate to cultural methods and uses, and the descriptions of those species on which alkali observations have been made. These are abstracted in abbreviated form, substantially as given by Mr. Ingham in his bulletin. Extracts have also been made from the admirable publications of Mr. Abbot Kinney of Los Angeles and Baron von Mueller of Australia, in which they describe the numerous species of Eucalyptus. Mr. Ingham, however, cautions eucalyptus planters not to rely on Australian experience as plantings in California seem to show material differences in success.]

Eucalyptus planting has now passed the experimental stage and may be considered without question as a commercial proposition. The value of the crop and the possibilities of growing it in California have been sufficiently demonstrated to make judicious plantings even on a large scale perfectly safe, with an assurance of sure and reasonably large profits. It is important, however, for the planter to consider, in the light of the best information, the nature of the product which he will produce, or, in other words, the market which he will attempt to supply with the Eucalyptus trees.

Since the introduction of the first species of Eucalyptus, the seeds of other species have been imported each year by seedsmen, nurserymen, and in many cases ranch owners until at the present time there are growing in the State nearly one hundred species. The University of California has seventy named species growing on the forestry station grounds at Santa Monica, California; there are specimen trees of nearly every species over ten years of age and bearing seed at the present time, while there are young trees of all the promising lumber eucalypts.

From this large collection there can be selected species that will grow on nearly any soil in a frostless region, while there are a few that can endure a temperature from 20° F. to 120° F, and at different altitudes; but with these trees it is as with any other, there is one location best adapted to the greatest development; it may be a situation near the coast in a foggy atmosphere, the river bottoms, the inland valleys or in swamps. Care should be taken in selecting a species for any certain locality, that the conditions there are the ones that will bring the species in question to the highest point of development.

EUCALYPTUS FOR TIMBER.

The wood of the different species of Eucalyptus varies from a wood as soft as that of our pines, to very hard, closed-grained and variously colored kinds equal to our native oaks and hickories. Among the large number of species may be found some that can be substituted for nearly all our present commercial woods, although the Eucalyptus wood is harder to work.

Eucalyptus timber is more costly to cut and mill than any of our native hardwoods; in planing, the lumber of many of the species has a tendency to chip on account of the irregular grain, while that of all of the species under the most careful handling season-cracks more or less on the ends. This fault can be overcome by having the logs sawed a foot or two longer than the finished product needs to be so that the season-cracked ends can be removed. Very little trouble is experienced in seasoning the lumber if the trees are cut down during the winter months and sawed while green, and the lumber then piled in high tiers to obtain weight, in some places protected from the wind and sun.

Strength Tests of Eucalyptus.—We reproduce the following, bearing on the strength of several species of Eucalyptus timber:

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE.

Trade Bulletin 8. October 8, 1906.

EUCALYPTUS FOR TIMBER.

The wood of the eucalypts has not been extensively used by manufacturers in the United States, because the supply has not been sufficient to establish a market. Blue gum, the most common species in California, has, however, competed with black locust for insulator pins, has given satisfactory service in chisel and hammer handles, and has been used locally for wagon tongues, axles, spokes, hubs, and felloes. It is hard, strong, and tough.

In coöperation with the State of California, the Forest Service recently completed a study of the mechanical and physical properties of the common eucalypts. The tests, made at the State University at Berkeley, were to determine whether Eucalyptus can be substituted for some of the hard woods that are becoming difficult to obtain.

Blue gum is by far the fastest growing species. The height and diameter of trees from which the test pieces were taken is given in the following table. All the trees were about fifteen years old:

Species.		Diameter, inches.	Height, feet.
Common name.	Botanical name.		
Blue gum	Eucalyptus globulus	30	101
Sugar gum	Eucalyptus corynocalyx	15	73
Karri	Eucalyptus diversicolor	16	72
Manna gum	Eucalyptus viminalis	12	60
Red gum	Eucalyptus rostrata	9	47
Leather-jacket	Eucalyptus punctata	10	43
Red mahogany	Eucalyptus resinifera	8	38

An important point in considering the value of commercial plantations of eucalypts is brought out in the next table, which shows that the fastest growing species are also the strongest. The tests were made upon kiln-dried material.

Species.	Bending.			Compression parallel to grain.	
	Age in years.	Number of tests.	Modulus of rupture pounds per square inch.	Number of tests.	Crushing strength, pounds per square inch.
Sugar gum	15	5	25,344	11	11,290
Blue gum	30	12	23,265	15	12,310
Leather-jacket	15	3	19,267	10	10,908
Karri	15	8	18,386	17	8,795
Blue gum	15	28	16,900	34	8,190
Red mahogany	15	4	14,550	2	7,920
Red gum	15	9	14,380	6	7,723
Manna gum	15	12	13,093	20	7,309

A comparison with Forest Service tests on hickory shows that 30-year-old blue gum is stronger than XXX hickory, and that 15-year-old sugar gum is nearly as strong as black hickory and 91 per cent as strong as second-growth hickory.

The wood of very young and sappy trees is apt to warp, but that from more mature growth can be easily handled to prevent warping. Early seasoning should proceed slowly. Open piling is desirable; the stacks should be high to secure weight, and should be covered.

Several of the Eucalyptus grow rapidly in California, and, under forest conditions, form straight, tall poles free from branches. They have, therefore, especial value as timber trees.

EUCALYPTUS FOR FUEL.

The wood of most of the eucalypts makes good fuel. A grove of blue gums five years old, set out 6 by 6 feet apart, under favorable conditions should yield from 50 to 80 cords of wood per acre, while at ten years of age 80 to 150 cords may be expected. Groves under irrigation will undoubtedly do better than the above figures indicate, while the quality of the land will also, of course, have a great influence. The cost of working up the standing trees into fuel ready to burn varies somewhat with the age and species of the trees.

EUCALYPTUS FOR OIL.

The leaves and twigs of the tree, when distilled, produce an oil which has great medicinal properties and is used quite extensively in medicine at the present time. This oil is a non-irritant antiseptic, which can be used without the slightest injury on all the tissues of the body and internally in very small quantities. The amount of oil that can be extracted from a certain number of pounds of leaves and twigs varies with the locality in which the grove is situated, in the different trees according to their positions in the grove and in the different species of Eucalyptus. The latter is also true in regard to its medicinal properties.

The leaves from the brush of ten cords of wood, cut from the *globulus* five years of age distil from one and a half to two and a half gallons of oil, or two tons of leaves and twigs will produce from three to four gallons.

According to Von Mueller, the following percentages of oil are obtained from the foliage of a number of species:

Species.	Volatile oil.
E. amygdalina	3.313 per cent
E. oleosa	1.250 per cent
E. leucoxylon	1.060 per cent
E. goniocalyx	0.914 per cent
E. globulus	0.719 per cent
E. obliqua	0.500 per cent

The lesser quantity of oil of *E. globulus* is, however, compensated for by the vigor of its growth and the early copiousness of its foliage. *E. rostrata,* though one of the poorest in oil, is nevertheless important for malarial regions, as it will grow well on periodically inundated places and even in stagnant waters not saline. Eucalyptus oils dissolve the following, among other substances for select varnishes and other preparations; camphor, pine resins, mastic, elemi, sandarac, kauri, dammar, asphalt, benzoe, copal, amber, shellac, caoutchouc, also wax but not gutta-percha. These substances are arranged in the order of greatest solubility.

THE EUCALYPTS AS BEE PASTURE.

All of the eucalypts have more or less value as bee pasture when in bloom, and from the large number of species growing in the State it is possible to select a group that will furnish bloom for the bees to work on the year round. If the natural pastures are good for all but a short period each year, it is possible to select one or two species of Eucalyptus that will fill in that time.

The list given below is made up from the data collected from two years' observation of the blooming periods of the Eucalyptus species on the Forestry Station ground. The names of the species are put down for the months when the most of the trees of that species are in bloom, although there are instances in every species where some one individual specimen will be found blooming at an entirely different period, or perhaps twice during the year. Some of the species have been considered injurious to bees, but we have never been able to find dead bees under the tree. The bees seem to have a preference for the white or greenish white flowers:

January: *globulus, leucoxylon, siderophloia, robusta,* and *melliodora.*

February: *globulus, robusta, polyanthema, leucoxylon,* and *melliodora.*

March: *globulus, robusta, leucoxylon, polyanthema, melliodora,* and *sideroxylon* var. *rosea.*

April: *leucoxylon, melliodora, Gunnii, polyanthema,* and *Stuartiana.*

May: *melliodora, Gunnii, maculata, cornuta, rostrata,* and *tereticornis.*

June: *melliodora, maculata, cornuta, tereticornis, rostrata,* and *citriodora.*

July: *citriodora, tereticornis, rostrata, viminalis, cornuta,* and *eugenioides.*

August: *viminalis, cornuta, Lehmannii, eugenioides, calophylla, corynocalyx,* and *resinifera.*

September: *Lehmannii, corynocalyx, calophylla,* and *resinifera.*

October: *calophylla, corynocalyx,* and *siderophloia.*

November: *corynocalyx, siderophloia, leucoxylon,* and *robusta.*

December: *globulus, robusta, leucoxylon,* and *sideroxylon* var. *rosea.*

EUCALYPTUS ADAPTED TO SPECIAL PURPOSES.

The species whose wood is the most durable in the soil:

Eucalyptus rostrata, tereticornis, rudis, diversicolor, sideroxylon var. *rosea, corynocalyx, citriodora,* and *crebra.*

The lumber species:

All of the species described herein are valuable as lumber trees, although the four following are considered the best among the eucalypts as commercial lumber trees: *Eucalyptus globulus, rostrata, tereticornis,* and *corynocalyx.*

The species for fuel alone:

All of the species are of more or less value for wood, but the following two species will produce more wood than any of the others on any good land. These two are the common blue gum, *Eucalyptus globulus,* and *viminalis,* the two most rapid growing gums we have in this country.

The most frost-resistant species:

Eucalyptus rostrata, globulus, viminalis, tereticornis, sideroxylon, crebra, rudis, robusta, resinifera, and *Stuartiana.*

Drought-resistant species:

Eucalyptus corynocalyx, microtheca, polyanthema, and *cornuta.*

POTASH IN EUCALYPTUS.

The potash obtainable from the ashes of various eucalypts varies from 5 to 27 per cent. One ton of fresh foliage of *E. globulus* yields about 8½ pounds of pearl-ash; a ton of the green wood, about 2½ pounds; of dry wood about 4½ pounds.

PLANTING AND CULTIVATION OF EUCALYPTUS.

Quality of Soil for Eucalyptus Planting.—The idea is too prevalent that Eucalyptus growing is exclusively a proposition for cheap, dry, or poor land. It is true that the trees, especially certain species, will live and grow fairly well under conditions where no other crop could be considered, and if the object is merely the utilization of such land to the best advantage Eucalyptus planting may be wise and somewhat profitable. For one, however, who is buying land for this purpose, or one who already has fairly good land capable of irrigation or naturally moist, it is becoming more and more apparent that good land, capable of culture and irrigation, will produce far more profitable returns on the investment by reason of the enormously more rapid growth and greater wood production of the trees. Under such conditions a crop of trees may be produced and marketed and the land then cleared for other purposes, or the stumps allowed to sprout for a second crop, when on poor, dry land, trees of the same age would not pay for cutting.

METHODS OF GROWING EUCALYPTUS.

The necessary conveniences for the propagation of the seedlings are as follows: seed boxes or flats, a good soil, seed true to name, plenty of water convenient to all flats, and in most localities a shade for the young plants from the sun is required.

The Soil for the Seed-bed.—It has been proven that Eucalyptus seeds will germinate and grow in nearly any soil, from a clear beach sand to adobe, but the best results are obtained if the seeds are sown in a light loam; in the transplanting flats a medium loam, mixed with about one fourth of well rotted manure, should be used.

Shade for the Young Plants.—Where a large number of plants are to be grown, a lath house, with the laths spaced their own width apart for the protection of the young plants from the midday sun, will be found more convenient than lath or cheese cloth screens laid on small frames above the flats, as the labor required to move them each time the plants are watered would amount to a large item of expense during the growing season. The lath house or the screens will also protect the seed flats from the ravages of the birds and the young plants from the frosts (if not too severe) during the cold weather of the winter months, before the time for setting in the field.

Time to Sow the Seed.—The time to sow the seed varies somewhat with the locality, but, as a general rule, the seed should be sown by the latter part of June or first of July, and the seedlings from these sowings will be large enough to be set out in the field the following spring, if they receive proper care while young.

Methods of Sowing the Seed.—The seed is generally sown broadcast in the seed-flats and the young plants transplanted once before being

set in the field; while others sow the seeds in hills and practice thinning instead of transplanting before setting out in the field. With either of these methods the flat is filled to a depth of two and one half inches with the prepared soil, pressing it down firmly in the boxes, the seed is sown and covered to a depth of not over one fourth of an inch with the same soil, sand or sawdust, pressing the covering firmly. The number of fertile seeds of any species to the pound is very high; the average number of transplanted plants raised to the pound is 12,000. The seed-flats should be kept damp through the heat of the day, until the young plants break through the ground, then care must be taken not to use too

FIG. 7.—Eucalyptus seedlings, *rudis* and *viminalis*.

much water and that there is good circulation of air over the flats, or the fungous disease "damping off" is liable to occur. This disease is most general on damp, cloudy days, and where the plants are watered late in the evening. Some species most susceptible to damping off are the *E. corymbosa, citriodora, calophylla, ficifolia,* and *globulus.*

Transplanting.—The seeds that have been sown broadcast in the flats can be transplanted, when the plants are two or three inches high, to other flats of prepared soil and spaced from one and a fourth to two inches apart; the soil should be kept damp and the plants protected from the direct rays of the sun for a few days.

The time to set the plants in the field varies with the climatic conditions or localities, and whether the plants are to receive irrigation or not. In localities where frosts are common through the winter months, it is

advisable to set the trees out as early in the spring as possible without endangering them to a late frost and still have them receive the benefits of the late rains, so that they will have a full season's growth to withstand the frosts of the following winter. If trees are to be irrigated they can be set out later in the season without danger of loss from want of moisture.

The size of the plants when set out in the field should not be under six or over ten inches in height, to secure a good stand. The land should be thoroughly plowed and harrowed before planting. The distance apart at which the seedlings should be planted depends upon the species of Eucalyptus, the soil, the distance to water and whether the trees are to be grown for fuel, ties, or lumber. Some of the species are naturally straight-growing trees, while others grow out of the perpendicular unless set in close plantings. In a rich, heavy, loam soil they may be planted as close as 6 by 6 feet or if irrigated 4 by 8 feet; on lighter soil 8 by 8 feet is the proper distance, or 6 by 10 if irrigation is practiced. The close planting has a tendency to sacrifice the diameter growth in favor of height, also making more erect trees and forming a perfect canopy with their crowns that will shade the soil, nearly preventing evaporation of the soil water.

Cultivation of the young trees should be carried on as long as possible without danger of injuring them; they can generally be cultivated for the first season and part of the second before the limbs of the trees spread out and interlap so as to make it impossible to drive between the rows.

Thinning of the Young Trees.—It is a self-evident fact that to grow large trees for lumber a greater space than 6 by 6 feet is needed for each tree to reach a large diameter, but at the same time it would be good management to set out just the number of trees to the acre which are expected to mature. Trees are killed by gophers and rabbits and by extremes of temperature, and it is practically impossible to replant in the missing spaces after the trees are one year old. A planting upon any good soil may with advantage be set out 6 by 6 feet apart and at the end of the first year a rigid thinning should be started, removing with a grub hoe all weak, inferior or injured trees. This thinning should be carried on until only the strong and healthy trees, or a certain number, remain to the acre.

The value of a plantation when ten years old will depend most largely on the care it has received during the first four or five years of its growth. One of the most essential points in regard to the growing of perfect trees is that they start to grow erect with clean trunks the first few years. Some trees will naturally start in this way, while others fork, producing a number of lateral branches on their trunks; each year

all limbs that have a tendency to deform the trees should be removed. After the third or fourth year the trees will have grown to such a height that to remove the limbs may prove impracticable in most cases, and then the poorer trees should be removed for wood or stakes to allow the remainder a larger area of soil to draw upon and a greater space above ground to extend their branches. At this time the trees on an acre can be reduced to a certain number, leaving those to grow for telephone poles, ties or lumber; or the entire grove may be cut for stakes and wood.

Sprouts.—Sprouts will start from the stumps in from three to six weeks from the date the trees are cut down, in any month of the year. The number of sprouts to the stump is generally large and varies with the species as shown in the following:

Species.	Diameter of stump.	Number of sprouts.	Height of sprouts.
E. polyanthema	3 feet	15	71 inches
E. stuartiana	5½ feet	59	71 inches
E. viminalis	11 feet	16	65 inches
E. corynocalyx	5½ feet	35	62 inches
E. siderophloia	4½ feet	55	47 inches
E. globulus	7½ feet	21	45 inches
E. punctata	5 feet	42	45 inches
E. tereticornis	4½ feet	2	42 inches
E. leucoxylon	5½ feet	52	41 inches
E. rostrata	5¼ feet	8	41 inches

The stump of the *globulus* had been driven over and many of the sprouts destroyed. To obtain the largest profits from the sprout growth in the shortest time, it is necessary to go over the planting, when the sprouts are from six months to a year old, and remove all but two to four of the largest and most erect growing, leaving them well spaced around the stump; if all of the sprouts are allowed to remain their growth is retarded.

The number of cords per acre at the second cutting is greater for the same length of time, and is due to the fact that the three or four sprouts make a more rapid growth than the parent tree because of a fully developed root system which is capable of supplying the food to a mature tree.

DESCRIPTION OF SPECIES OF EUCALYPTS.

Mr. Ingham selects the following eighteen of the many species of Eucalyptus as being the most promising for commercial planting in California, and describes each in his bulletin:

E. botryoides	*E. viminalis*
corynocalyx	*citriodora*
crebra	*corymbosa*
globulus	*diversicolor*
robusta	*leucoxylon*
rostrata	*polyanthema*
rudis	*punctata.*
sideroxylon var. *rosca*	*resinifera*
tereticornis	*siderophloia*

Those of the first column comprise the species which have been tested more or less as to their tolerance for alkali salts, and whose descriptions by Mr. Ingham are repeated in this bulletin. To these are added *E. Gunnii* and *amygdalina* from the publications of Mr. Abbot Kinney and Baron von Mueller. The illustrations given of these species are from the bulletin of Mr. Ingham.

For fuller details, and for descriptions of other species than given here, those interested are referred to the publications of Professor McClatchie and Messrs. Abbot Kinney, von Mueller, and Ingham.

Eucalyptus Amygdalina. Brown or White Peppermint Tree.

The following description of this important species of Eucalyptus is given by Baron von Mueller. In sheltered, springy, forest glens it attains exceptionally a height of over 400 feet there forming a smooth stem and broad leaves, producing seedlings of a foliage different from the ordinary form of *amygdalina*, which occurs in more open country and has small, narrow leaves and a rough, brownish bark. The former species or variety, which has been called *E. regnans*, represents probably the loftiest tree on the globe, attaining a height of 415 feet with a diameter of 15 feet, a considerable distance above ground. Another tree measured 69 feet in circumference at the base of the stem; at 12 feet above ground it had a diameter of 14 feet, at 78 feet a diameter of 9 feet; at 144 feet a diameter of 8 feet, and at 210 feet a diameter of 5 feet. The wood is fissile, well adapted for shingles, rails, staves, inner building material and many other purposes, but it is not a strong wood. That of the smaller, rough, barked variety has proved lasting for fence posts.

It has endured the frosts of the milder parts of England with *E. Gunnii* and *cordata*. In New Zealand it has survived the cold where *E. globulus* succumbed. This species yields more volatile oil 3.3 per

cent in the foliage) than any other hitherto tested and is therefore largely chosen for distillation.

Mr. Abbot Kinney says that while *E. amygdalina* of Australia is the tallest tree in the world, yet the *amygdalina* in southern California has in no case equalled in size local blue gums. Its manner of growth here gives little prospect that it will ever surpass *E. globulus.*

Eucalyptus Botryoides. Bastard Mahogany.

From East Gippsland to South Queensland. Vernacular name Bastard Mahogany, and a variety called Bangalay, the latter generally found on coast sands. One of the most stately among an extensive number of species remarkable for its dark-green shady foliage. It delights in river banks, but it will thrive also on ground with stagnant moisture. Grows splendidly at the city of Algiers (Prof. Bourlier). Stems attain a height of 80 feet without a branch and a diameter of 8 feet. The timber usually sound to the center, adapted for waterworks, wagons, particularly for felloes, also knees of boats. Posts formed of it are very lasting, as no decay was observed in fourteen years; it is also well adapted for shingles. (Von Mueller.)

Mr. Norman Ingham, in charge of the Santa Monica Station, in Bulletin No. 196 of this Experiment Station, says of the *botryoides:* The trees of this species are very erect in growth, but branched; the bark of the trunks of the old trees is reddish-brown in color, rough and nearly persistent; the limbs are generally smooth, shedding their bark in long strips. The leaves are lance-shaped, leathery in texture; in color the upper surface is a dark green, while the lower surface is much paler. The flower clusters are borne laterally on compressed stalks. The seed cases are five to seven in number, deep, cup-shaped and stemless.

The timber of this species is considered by the Australian writers to be one of the best of eucalypts, when it is grown where there is plenty of water. It makes the best of wind-breaks and is one of the best eucalypts to use as a shade tree.

Eucalyptus Corynocalyx. Sugar Gum.

Trees of this species in close planting grow erect, having a very open crown, while individual specimens branch low, with the branches scattering. The bark of the trunks of the old trees is deciduous, and of a scaly appearance, due to the unequal flaking off at different times of the year. In color it varies from a cream to a dark gray.

The branches are smooth, shading off in color to a light green, while the twigs, young seedlings and sprouts are of a reddish hue. The leaves of the young plants are ovate, dark green in color on the upper side of the leaf and several shades lighter underneath. Those of the old trees

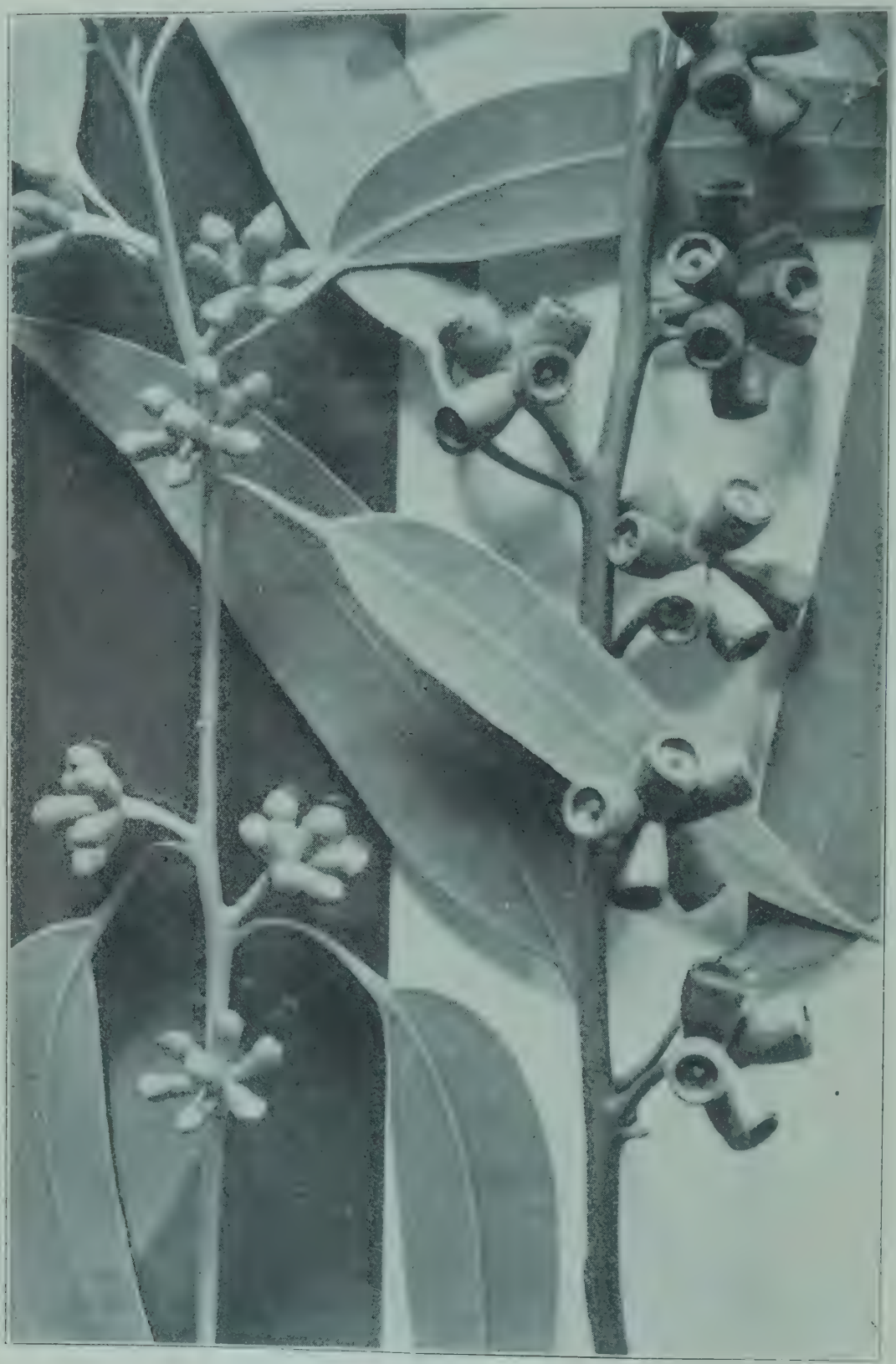

FIG. [illegible].—Eucalyptus botryoides. Natural size.

are long, slightly curved and sharply pointed, somewhat leathery in texture, dark green on the upper side and lighter in color beneath.

The buds are borne laterally and bloom during August and September; umbels alternate, solitary, pedicles short, the buds with their deciduous calyx cups are dumb-bell shaped, while the mature fruit is egg-shaped, with the valves three or four in number, generally three, enclosed. The seed ripens during the summer months and is brown in color and the size of the blue gum seed, but not so angular.

The lumber of the sugar gum is of a yellowish white color, easy to work when green but very hard if allowed to dry. This wood is very closed grained and hard, and tested very high at Berkeley in the tests carried on by the United States Forestry Service. The wood can be used for the same purpose as the blue gum wood, and is durable underground.

Trees of this species reach their best development in the southern part of the State. The sugar gum has been given a thorough trial in both the San Joaquin and Sacramento valleys, but in every case known to the writer they have been killed by the frost. Some of the best growths of this tree can be seen at Riverside, or in the towns along the coast from San Diego to Santa Monica. This is one of the trees much used in southern California as a street tree, especially at and around San Diego. It is to be found growing as wind-breaks around Riverside, San Bernardino, Colton, Ontario, Pomona, and San Dimas.

This species is one of the most drought resistant and valuable eucalypts that can be set out commercially, but it succumbs to frost. It is of a much slower growth than the other commercial eucalypts, coming after *rostrata,* as a rule.

Von Mueller says of the *corynocalyx:* A timber tree attaining a height of 120 feet, length of bole to 60 feet, circumference at 5 feet from the ground reaching 17 feet. The base of the trunk often swells out in regular tiers. The wood remarkably heavy, very dense, hard and strong, less liable to warp than that of many other kinds of Eucalyptus wood (J. E. Brown). It has come into use for fence posts and railway sleepers, naves and felloes. Its durability is attested by the fact that posts set in the ground fifteen years, show no sign of decay. The tree thrives well even on dry ironstone ranges. The sweetish and pleasantly odorous foliage attracts cattle, sheep and camels, which browse on the lower branches, as well as on saplings and seedlings. Scarcely any other eucalypt is similarly eaten (J. E. Brown). It should, therefore, be planted on cattle- and sheep-runs in arid districts, to furnish additional provender.

FIG. 9.—Eucalyptus corynocalyx. Natural size.

Eucalyptus Cornuta. The Yate.

Eucalyptus cornuta, the "yate," is a very attractive, graceful tree. Its foliage is greener than that of the blue gum, and tends to persist in the round or oblong form of leaf. It is a rapid grower and resists drought on light soil better than *E. globulus* or *E. viminalis. Eucalyptus cornuta* is one of our hardiest and fastest growing Eucalypti. The bark is a pleasant light drab color and nearly smooth. The tree grows tall, has great vigor in our valleys, and the timber is valuable. While it does branch low it makes a large, handsome tree with plenty of foliage. The flowers are so large and close in the umbel that each umbel looks like a large, single, pompon flower of delicate light green or light straw color. Its name comes from the long, horn-like cap of the flower. (Abbot Kinney.)

Von Mueller says: The yate tree of southwestern Australia is a large tree of rapid growth, preferring a somewhat humid soil. The wood is used for various artisans' work, and preferred there for the strongest shafts and frames of carts and other work requiring hardness, toughness and elasticity, and is considered equal to ordinary ash wood. The tree appears to be well adapted for tropical countries.

Eucalyptus Crebra.

The narrow-leaved ironbark-tree of New South Wales and Queensland. Wood reddish, hard, heavy, elastic and durable; much used in the construction of bridges and for railway sleepers, also, for wagons, piles, fence posts. This species is of an erect growth and has a very rough, persistent bark of a light grayish color, the rough bark extending to the limbs and small twigs, which are smooth. The leaves are long, narrow, equally dark green on both sides and pendulous, giving the trees a weeping effect. The mature seed cases are borne in paniculated umbels, and are small cup-shaped, with the valves, generally four in number, enclosed. The wood is hard, durable and of a reddish color, considered valuable. This species has the power to resist frosts and is found growing in Fresno and in the southern part of the State. It is being set out in great numbers at the present time by companies, in commercial plantings. In rapidity of growth this species ranks near the *Eucalyptus rostrata.*

Eucalyptus Globulus. Blue Gum.

Individuals of this species grow erect as a rule, branching low in isolated specimens, while those in close plantings have small crowns and are practically free from lateral branches. The bark of the seedlings is light bluish green in color, while that of the trunks of the old trees varies from a light brown to a gray or greenish color due to the flaking off of the bark in long strips. The limbs are generally smooth.

FIG. 10.—Eucalyptus crebra. Natural size.

The stems of the seedlings are rectangular in shape, while their leaves and those of the sprouts of the old trees are opposite, oblong, blunty pointed, and of a light bluish green color, darker on the upper side of the leaf. Those of the old trees are elongated, sickle-shaped, leathery in texture, and equally dark green on both sides.

This species is in bloom from January to May, the flowers being white in color, generally solitary, axillary and borne on short stalks. The whitish buds are angular, with a bluntly-pointed saucer-shaped deciduous cap, while the mature fruit is dark green in color, with from three to five valves, generally four, barely enclosed.

Trees of this species endure the frosts of the Sacramento Valley as far north as Red Bluff, Tehama County, and the dry heat of the San Joaquin Valley. It is found in nearly every town south of San Francisco to San Diego, and out of the edge of the Imperial desert region. A large number of blue gum seedlings have been set out in Imperial Valley, but nearly all have died on account of the intense heat, while the trees of the species *rostrata* and *rudis* have survived the heat and are making wonderful growths under irrigation.

The blue gum reaches its greatest development along the coast and river bottoms, where the annual rainfall is fifteen or more inches, and foggy days are common; although trees of this species are to be found growing on lands varying from an alkali to a rich loam, and at varying elevations from river bottoms to hilltops.

The lumber of this species is durable above ground, and is being sawed at San Jose, California, for the felloes, poles, reaches and singletrees of wagons, and flooring, insulator pins, and, in fact, anything that requires strength. It is valued at the same price as that of oak lumber, which it is slowly replacing. The wood is yellowish white in color, closed grained and easily polished. It has a tendency to chip when planed, on account of a wavy grain.

The leaves from the blue gum furnish practically all of the Eucalyptus oil in this country, as it is claimed by the distillers that it is the only species producing sufficient quantity of oil per hundred pounds of leaves to make distilling a profitable business.

This species, *Eucalyptus globulus,* is undoubtedly better known than any of the other eucalypts in this State, and is recognized generally in the State as one of the fastest growing trees in the world.

Mr. Abbot Kinney says of the *globulus:* The blue gum is a sort of average Eucalyptus, tall, but not the tallest; used for general purposes, even to piling and ship building; it is not the best of timber for any of these purposes; not the most lasting in the air, ground or water; not the highest yield of oil; not the best honey-making tree for bees. It is still well up in all of these respects. Like nearly all eucalypti the tree should be cut when the sap is least active and should be worked

FIG. 11.—Eucalyptus globulus. Natural size.

into its final form of firewood, boards, etc., as soon as possible after it is felled. I have seen blue gum logs become so hard that the cost, from increased difficulty of handling, ate up more than the final value. In many places this tree does well singly and in single lines, and it will furnish a continuous supply of firewood, as on the borders of fields and orchards that are cultivated, when it will amount to little or nothing in solid plantations. * * * A continuous supply of firewood can be obtained from the blue gum by pollarding or cutting the tree back every three or four years; it stands this treatment especially well while some of the other species do not take kindly to it. The sprouting of the blue gum when cut adds to its value as a fuel tree, for in all plantations it makes its first crop in about seven years and than for an indefinite period renews the crop every three or five years.

The *E. globulus* accommodates itself to more conditions in a satisfactory way than any other Eucalyptus. Yet there is no one condition for which some other species of this genus is not better adapted. So also there is no use to which the blue gum is put for which another species is not more serviceable.

Eucalyptus Gunnii. Swamp Gum Tree.

In the lowland along fertile valleys *E. Gunnii* attains a considerable size and supplies a strong, useful timber. It is this species that survived the severe frosts at Kew Gardens. Bees obtain unusually much honey from the flowers of this species. Cattle and sheep browse on the foliage. (Von Mueller.)

Mr. Abbot Kinney describes it as being a green, attractive looking and rapid growing tree and often a very fantastic grower in California, bending entirely over and sweeping the ground with its branches; it is one of the best frost resisters among the eucalypts but contains only a small per cent of oil.

Eucalyptus Robusta. Swamp Mahogany.

The swamp mahogany is one of the erect, but slow growing eucalypts. The trunks of the young trees are of a reddish gray color, slightly rough or stringy, while the limbs are smooth and dull red. The bark of the old trees is very rough, stringy and persistent.

The leaves are of a leathery texture, broad and lance-shaped, with the veins parallel and nearly at right angles to the midrib; in color they are dark green on the upper surface, while the under surface is several shades lighter.

The buds, with their deciduous calyx caps, are club-shaped and are borne in clusters of five to eleven. These clusters, or umbels, are axillary and their stalks are flattened. The mature seed cases are deep cup-shaped, with the valves enclosed.

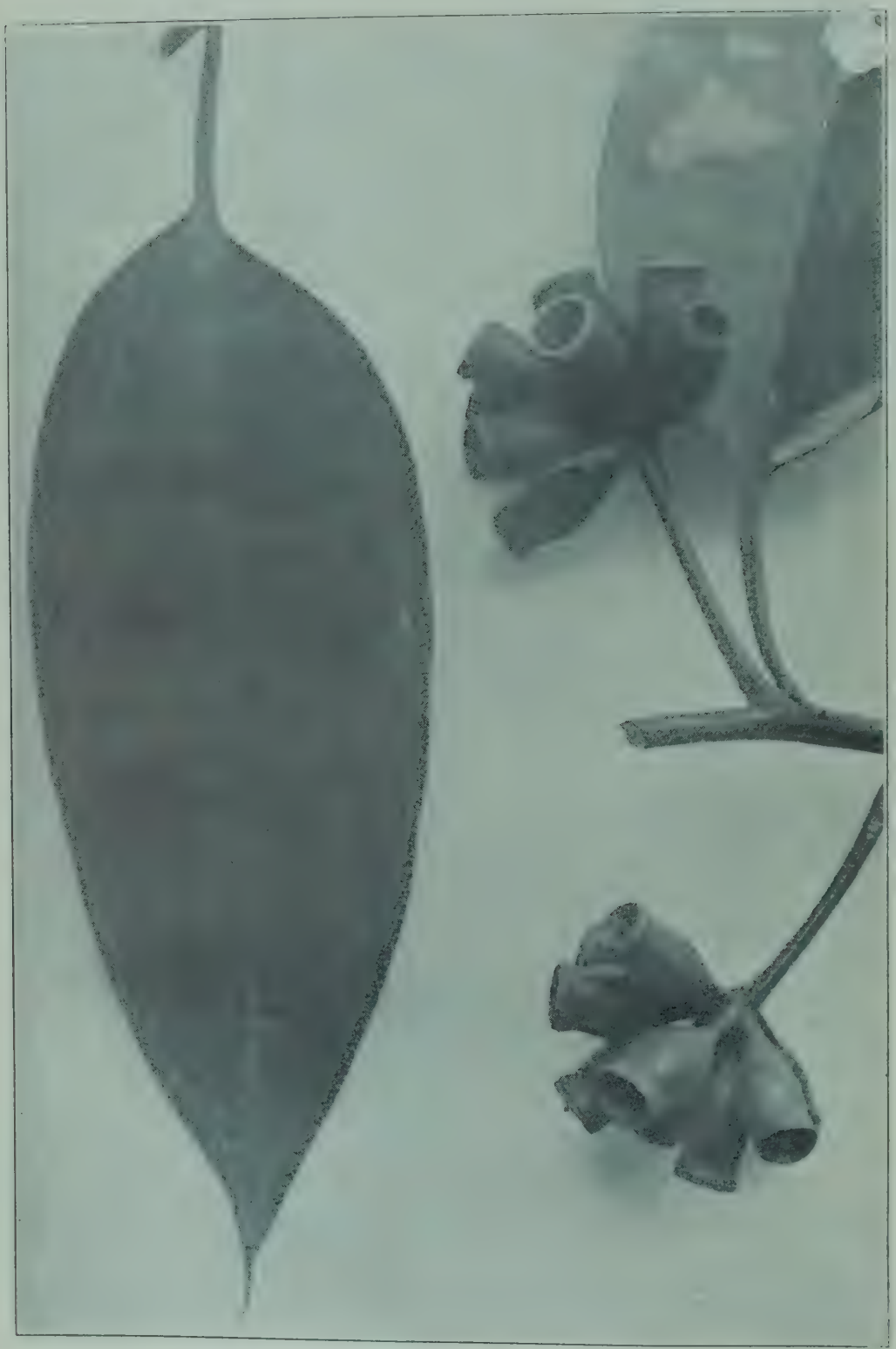

FIG. 12.—Eucalyptus robusta. Natural size.

The wood is not very valuable to work, as it is very brittle, but it is durable in the soil. The trees, if grown in a place exposed to the wind, are liable to break off when they have reached a height of from 15 to 30 feet.

Eucalyptus robusta is much used for street planting, and makes one of the best street trees to be found among the species of Eucalyptus, except for its tendency to break down. It will withstand low temperatures.

It reaches its greatest development where there is plenty of water, as in river bottoms, swamps and depressions in fields where the winter rains settle.

Eucalyptus Rostrata. Red Gum.

Trees of this species are of a slower growth than the blue gum and grow very crookedly even in close plantings.

The bark of the seedlings and the twigs of the old trees have a reddish hue, while that of the trunks of the mature trees is a very dark gray, varying from smooth and non-persistent in some trees to others where it is deeply furrowed and persistent. The limbs are much lighter than the trunk and smoother.

The leaves of the seedlings are broad lance-shaped, darker in color on the upper side, while those of the older trees are elongated, narrow, sickle-shaped, and equally green on both sides. The umbels are solitary and axillary. The flowers are borne in clusters of from three to fourteen, generally seven, in one fourth inch pedicels.

The buds, with their hemispherical, sharply-pointed lids, are nearly round and a little larger than a BB shot, valves three to five in number, generally four, very much protruding on the mature fruits.

The wood of the red gum is very durable both above and below ground and can be easily worked when green. It is possible to saw the wood up into the thinnest of lumber and veneers. In color the wood varies from a very light to a dark blood red. This is very heavy and takes a fine polish, but according to strength tests it is inferior to both sugar and blue gums.

The present range of *Eucalyptus rostrata* extends south from Chico, Butte County, in the Sacramento Valley, throughout the San Joaquin Valley, into the southern part of the State, and this species has shown its ability to stand the intense heat of the Imperial Valley throughout its entire length to Calexico on the Mexican border. In every instance where this tree was found in the Imperial Valley it was making a good growth, with proper care, notwithstanding the heat.

The red gum makes a good growth on alkali soils in the San Joaquin Valley and is one of our most drought resistant trees of any commercial

FIG. 13.—Eucalyptus rostrata. Natural size.

value, other than the sugar gum or *corynocalyx*. It is a slow growing species in regard to height, but one of the first in regard to diameter.

Baron von Mueller thus speaks of the *rostrata:* It attains exceptionally a height of 200 feet with a comparatively slight stem, but it is mostly of a more spreading habit of growth than the majority of its tall congeners. The timber is one of the most highly esteemed in all Australia among that of the eucalypts, being heavy, hard, strong and extremely durable, either above or under ground or in water. For these reasons it is very much prized for fence posts, piles and railway sleepers. For the latter purpose it will last at least a dozen years, but if well selected much longer. Indeed, sleepers were found quite sound after being 24 years in use. It is also extensively employed by ship builders for main stem, stern post, inner post, deadwood, floor timbers, transoms, knighthead, hawse pieces, bottom planks, breast hooks and riders, windlass and bow rails. It should be steamed before it is worked for planking. Also largely used for felloes, buffers, and posts and any parts of structures, which come in contact with the ground; not surpassed in endurance for woodbricks in street paving and for tramways.

Eucalyptus Rudis.

Trees of this species are erect, branching low in individual specimens, but having clean trunks in close plantings. The bark of the trunks is persistent, slightly rough, but not deeply furrowed; in color it is gray. The leaves of the young plants are oval and of a purple hue, while those of the old trees vary, oval to lance-shaped. The buds, with their blunt, cone-shaped deciduous calyx caps, are borne on medium length stalklets, in clusters of from five to nine. The solitary umbels are axillary. The mature seed cases are broad cup-shaped, with the valves, from four to six in number, slightly protruding.

There are two different trees in the State recognized as *Eucalyptus rudis:* the tree called *rudis local* in the southern part of the State has a smooth-barked trunk, as a rule, and the wood is inferior, dark brown in color and light.

The species described grows in the vicinity of Fresno, and is a superior tree, with the wood of a light brown color, hard and easily polished.

The wood of this latter tree is very durable; there are records of posts standing in the ground for eleven years without signs of decay.

Eucalyptus rudis is capable of enduring low temperatures, as well as the *globulus.*

The *rudis* in Arizona called the desert gum, is reported by the experiment station (Timely Hints for Farmers, No. 68) as being one of the most rapid growing of the eucalypts, especially when young. At "Tucson it has shown itself extremely resistant to summer heat and winter cold, having never suffered therefrom; it is also drought resistant."

FIG. 14.—Eucalyptus rudis. Natural size.

Eucalyptus Sideroxylon var. **Rosea.** Victoria Ironbark.

This species has a tendency to grow crooked and branched. The bark is deeply furrowed and persistent, giving to the trees a burned appearance, which is characteristic of this variety. The foliage of the tree is beautiful, of a bluish tint and pendulous, producing a weeping effect. The leaves are of medium width and length, of a light bluish green color. The buds are borne in solitary axillary umbels, in clusters of generally seven on one fourth inch stalklets. In shape they are cylindrical, with a conical calyx cap. The flowers are pinkish in color and in bloom from March to June.

The mature seed cases are deep cup-shaped with the rim compressed, and the valves, which vary from four to six, deeply enclosed. The wood of this species is of a dark brown color and particularly hard, heavy and durable.

Eucalyptus Tereticornis. Forest Gray Gum.

This species is of a very erect habit of growth, both in close plantings and isolated specimens. The branches are few and scattering, leaving the crown open. The deciduous bark of the trunks of the old trees is generally smooth and of a mottled color, from light brown to cream, directly after the bark has been shed. The buds are in bloom during May and June, and are borne laterally in solitary umbels, in clusters of from five to nine, on short stalklets. The deciduous lid is horn-shaped; reddish brown in color, just before blooming time.

The seed cases are slightly larger than those of *Eucalyptus rostrata;* with the valves, three to five in number, generally four, protruding and hemispherical. The leaves of the young plants are broad lance-shaped, while those of the old trees are long, of medium width and light green on both sides. The pendulous branches with their long leaves give to the trees a weeping effect. The wood of this species is close grained and durable, varying in color from a white to a light brownish red, and can be used in wheelwright's work, etc.

Undoubtedly *Eucalyptus tereticornis* can withstand as wide a range of temperature and of variation in soils, over as large a range of the State, as the red gum.

FIG. 15. Eucalyptus sideroxylon. Natural size.

FIG. 16.—Eucalyptus tereticornis. Natural size.

Eucalyptus Viminalis. Manna Gum.

There are two varieties of this species, both erect-growing trees. The trunks of one variety have a bark not dissimilar to that of the *globulus*, while that of the other has a smooth bark, white in color and deciduous. The bark is shed each year just as the trees are entering the blooming period. The leaves of the young plants and the sprouts of the old trees are from two to three inches long, narrow and opposite; while those of the old trees are long, narrow, slightly curved, of a dull green color, pointed and pendulous, giving to the trees a weeping effect. The stemless buds, with their conical, deciduous calyx cap, are borne in threes on slightly flattened stalks. The mature seed cases are goblet-shaped, with the valves, four in number, barely protruding.

The wood of the species is inferior to that of the red gum, both in strength and durability, although it is useful in rough carpentry, and in making fruit boxes, or any other light shipping boxes. In color the sap wood is light brown, changing to a yellowish white in the older wood.

The *viminalis* or manna gum withstands low temperatures equally as well as the red gum or the blue gum, and is growing at Chico, Butte County, in greater numbers than any other eucalypts.

Although this species is not a very valuable timber tree, it makes an average wood for fuel purposes, and can be grown on land under conditions where many of the other and more valuable species would barely live and make only an inferior growth.

Von Mueller in describing this species remarks that in the rich soil of the mountain forests of Australia it attains gigantic dimensions, rising to a height of rather more than 300 feet, with a stem occasionally 15 feet in diameter. It is the only species of eucalypt which yields the crumb-like melitose-manna copiously.

FIG. 17.—Eucalyptus viminalis. Natural size.

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